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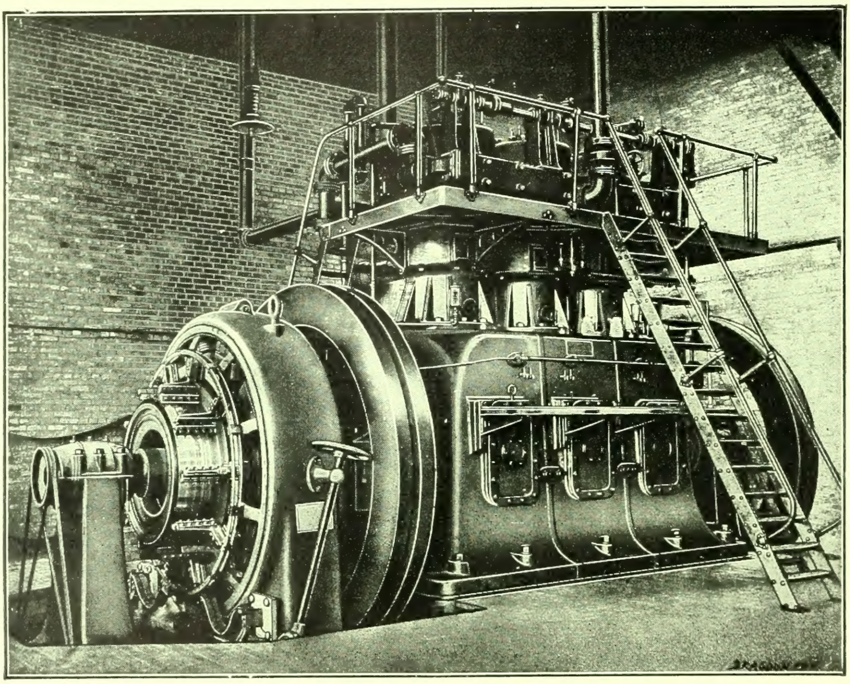

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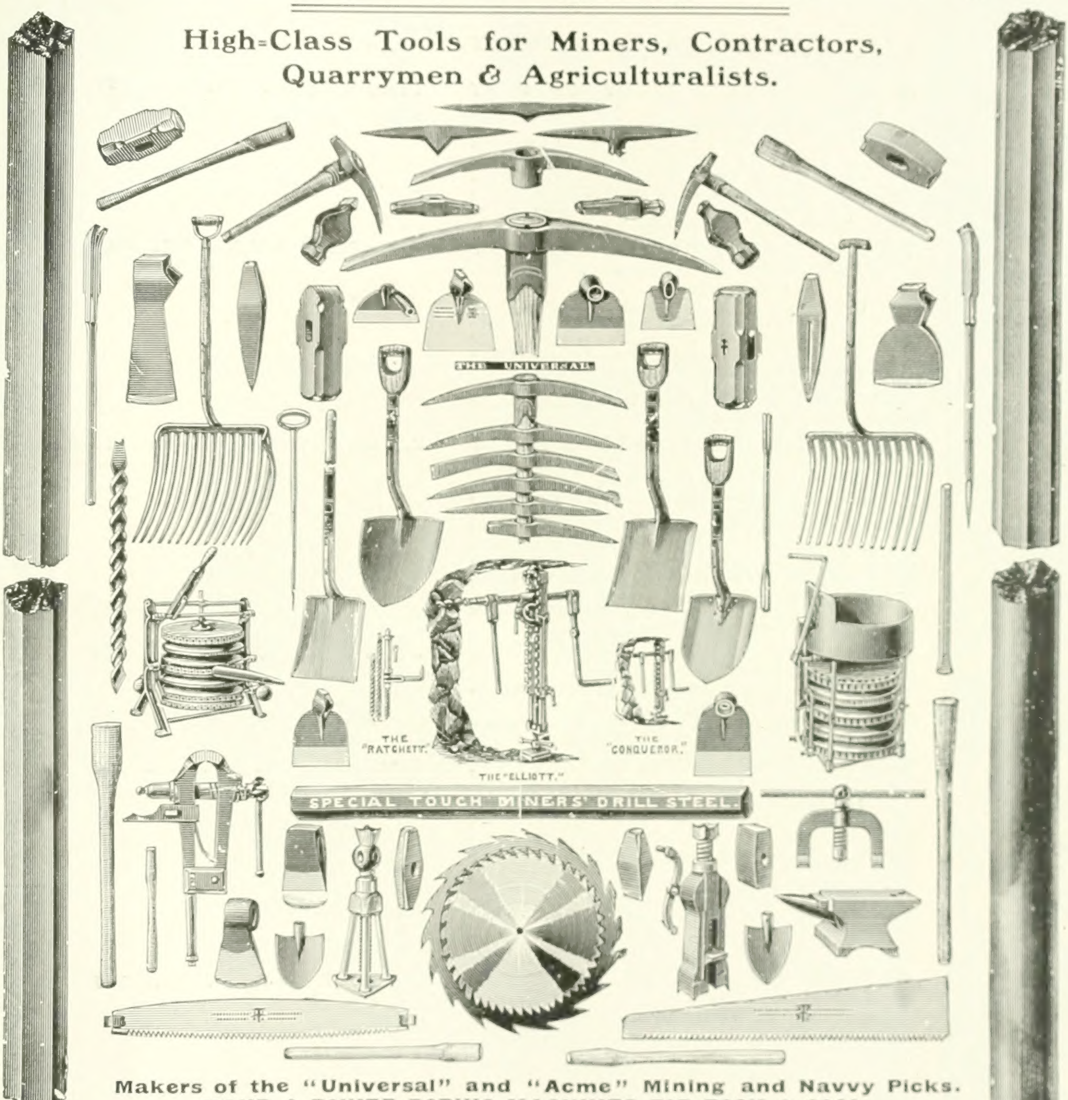
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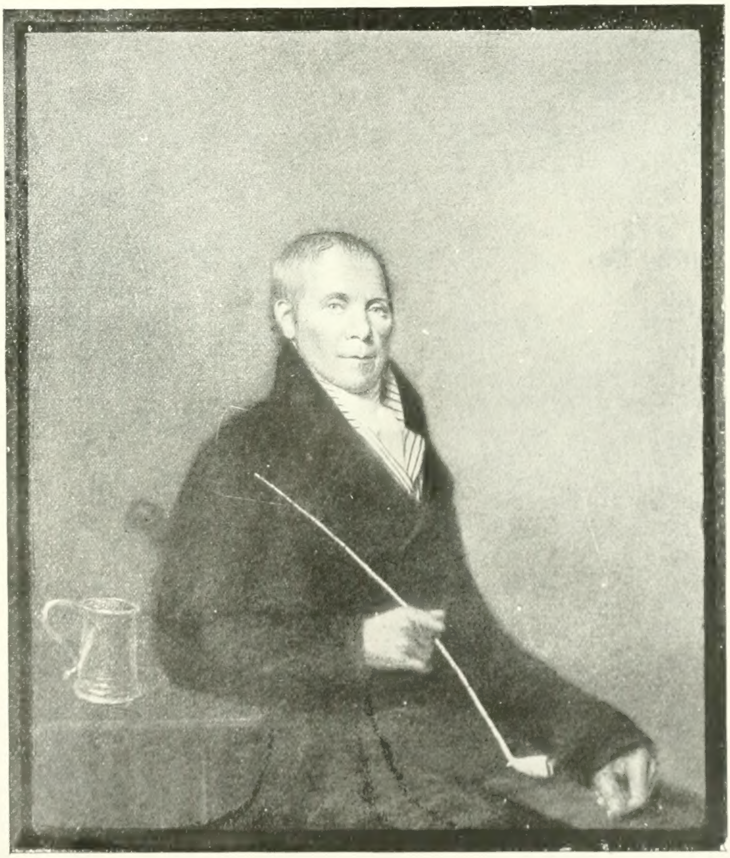

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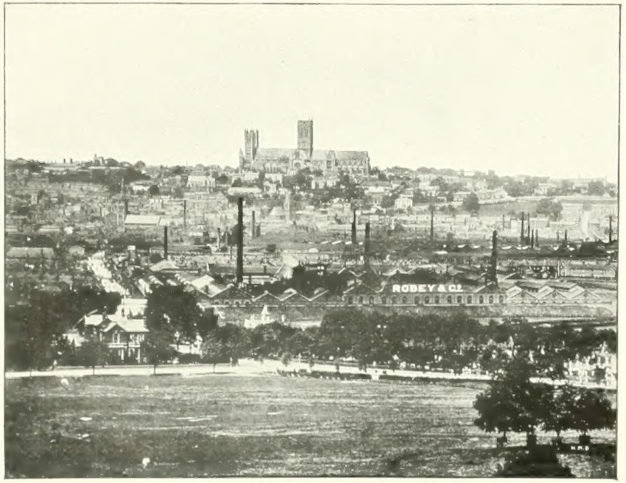

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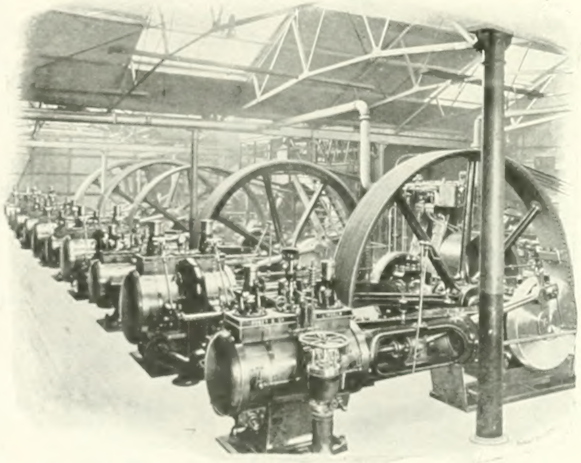

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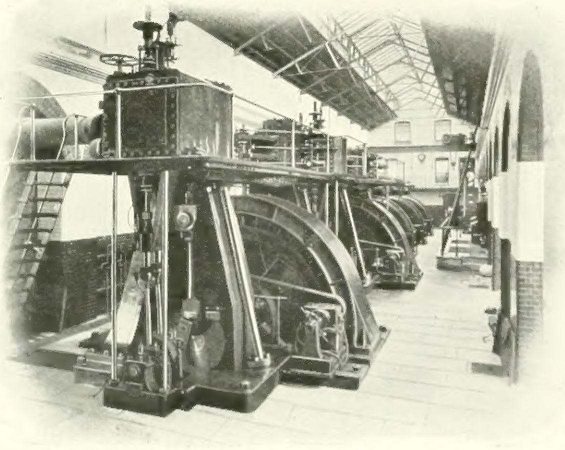

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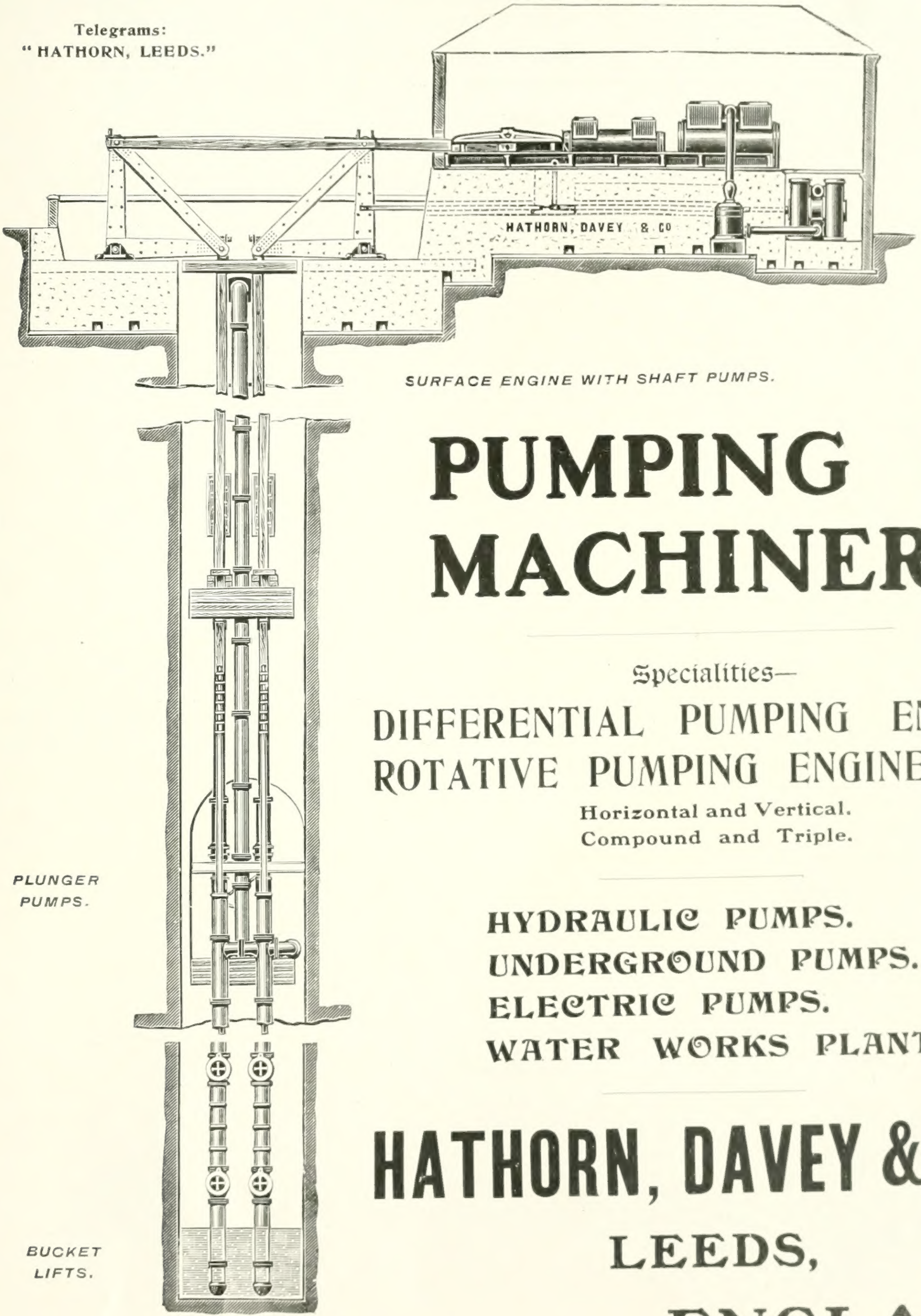

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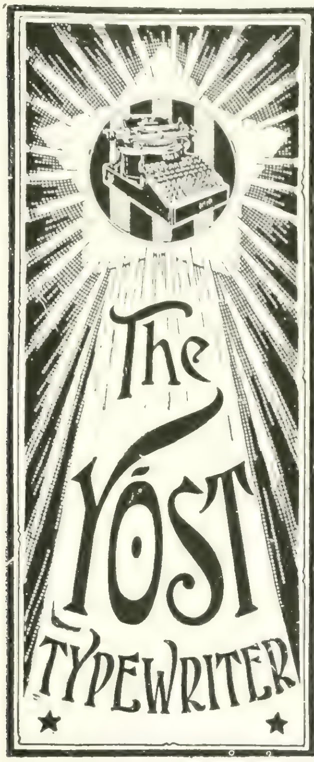

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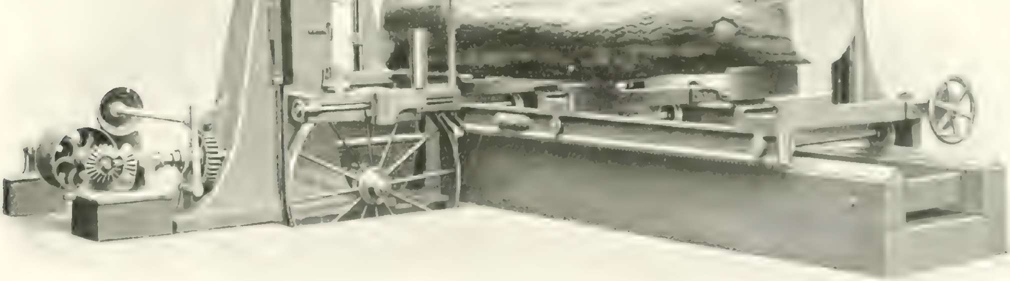

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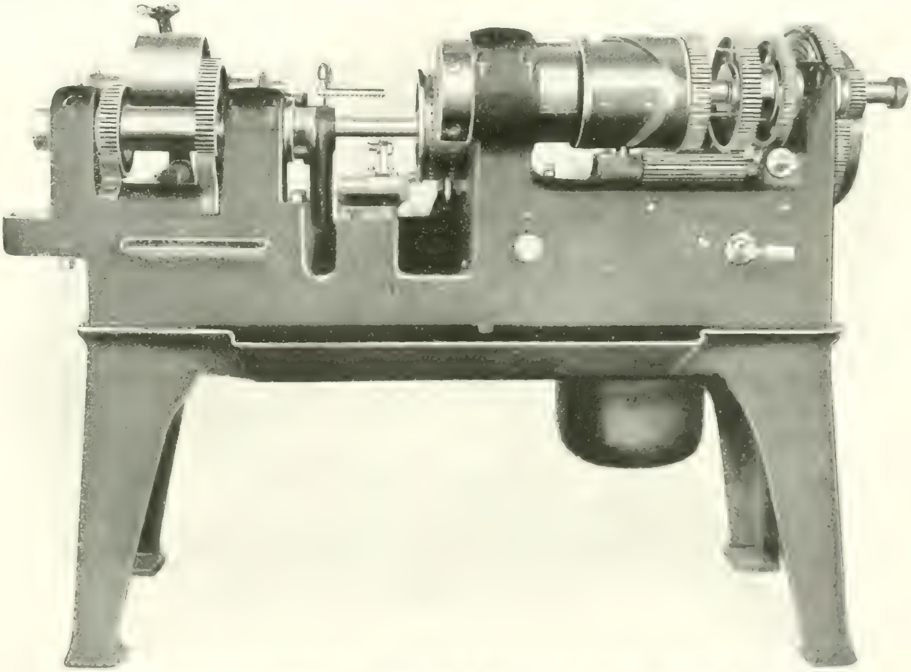

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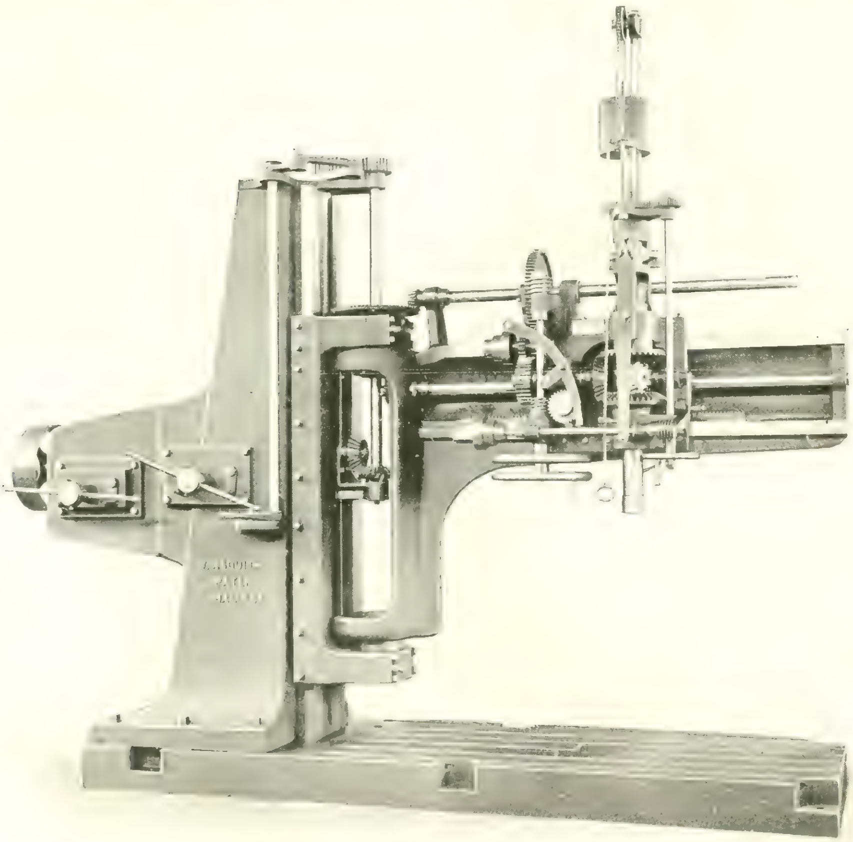

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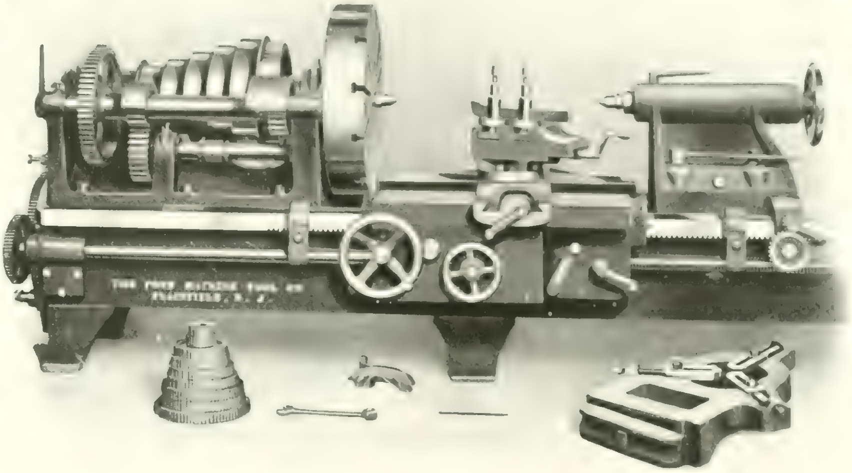

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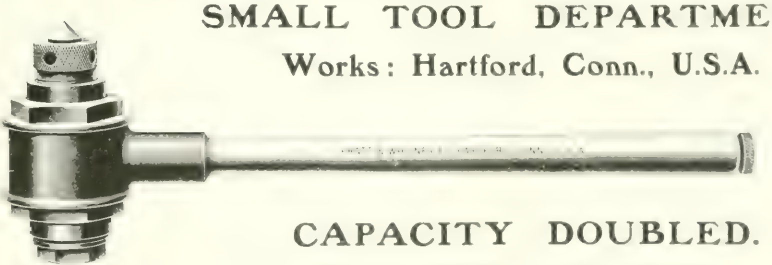

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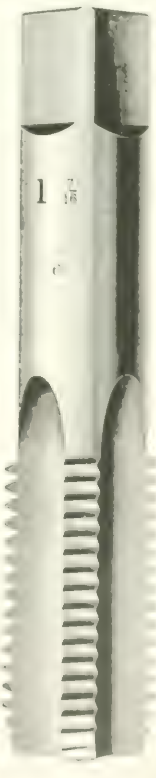

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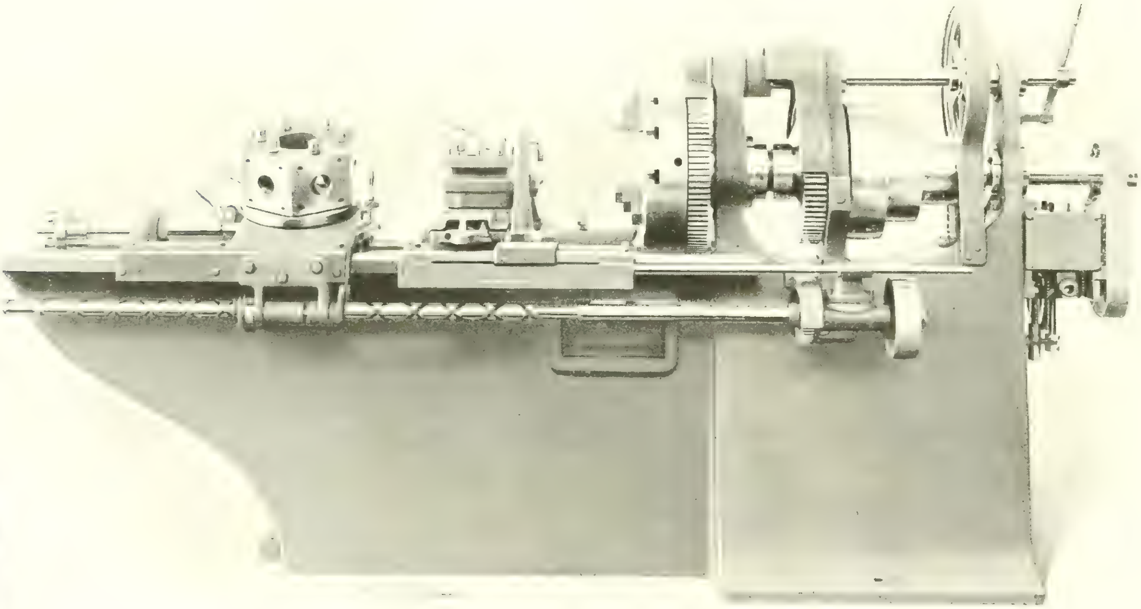

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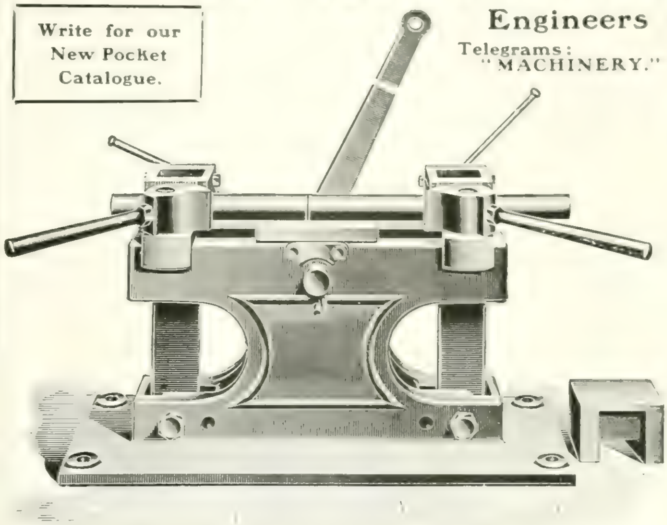

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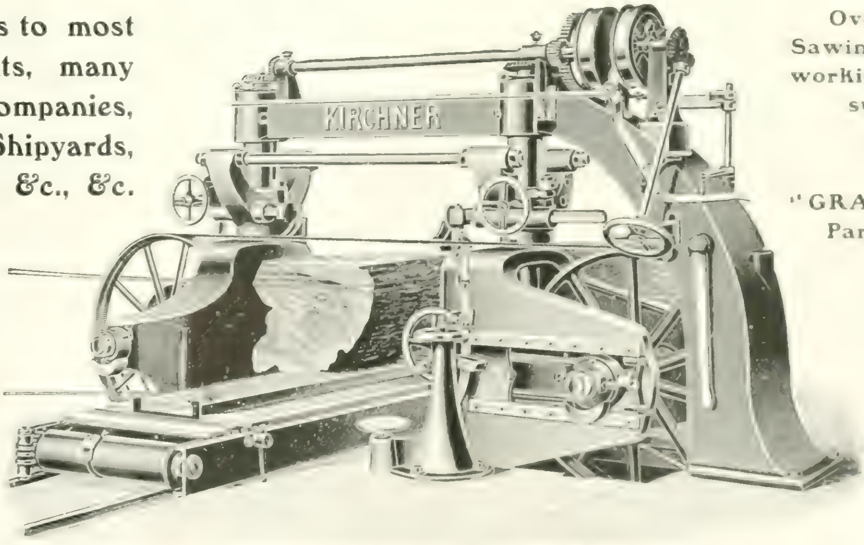

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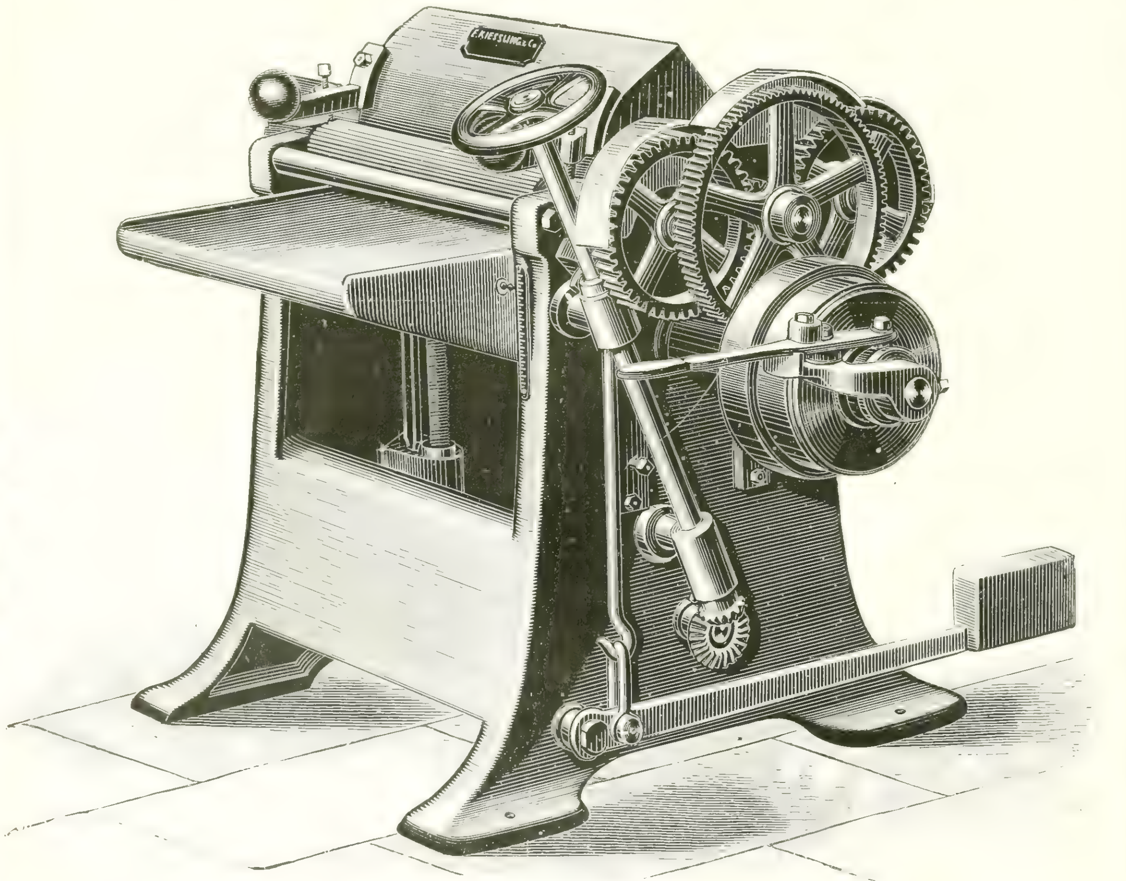

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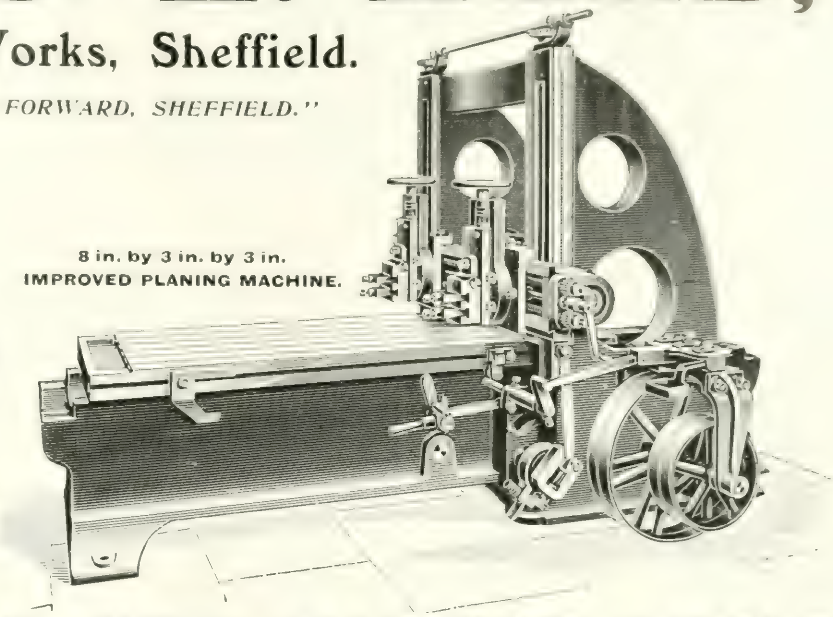

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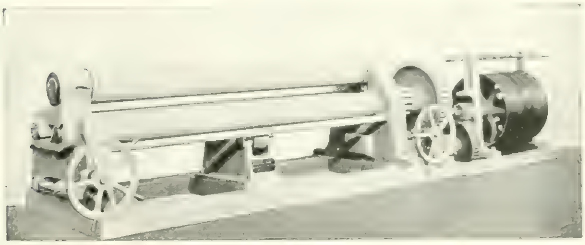

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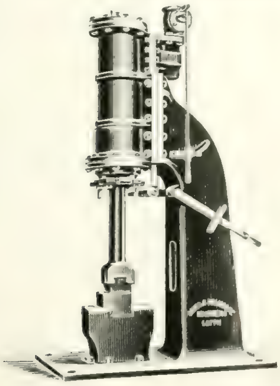

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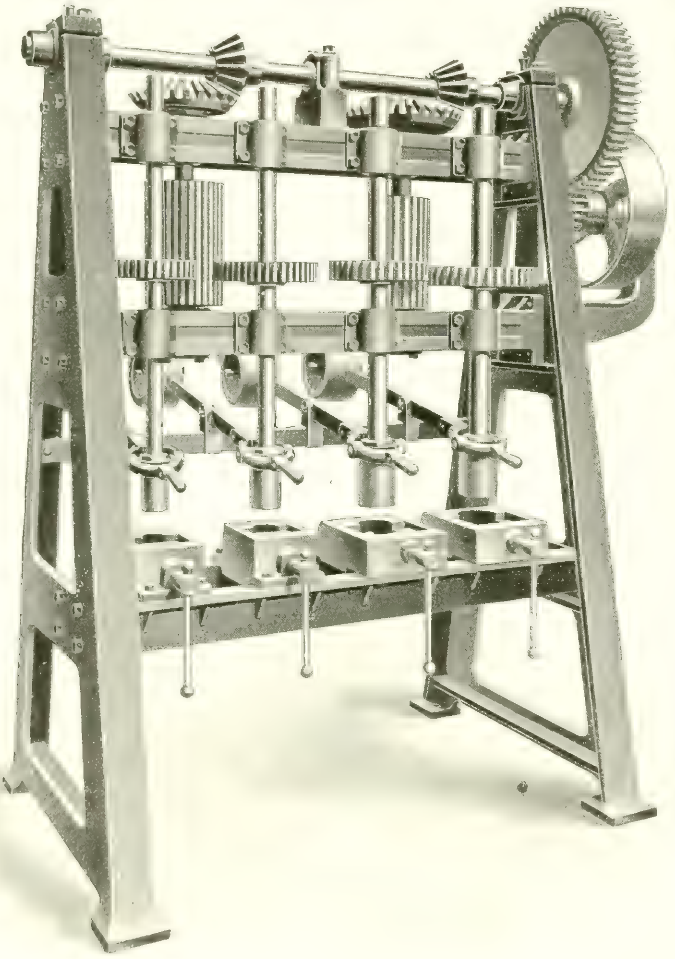

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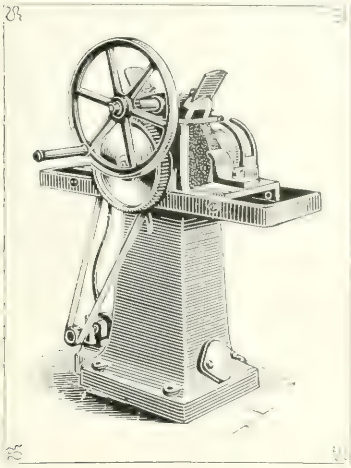

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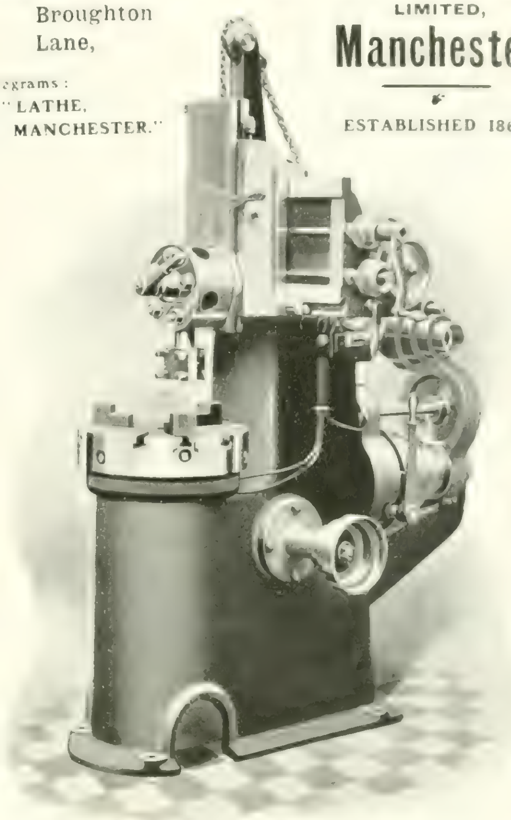

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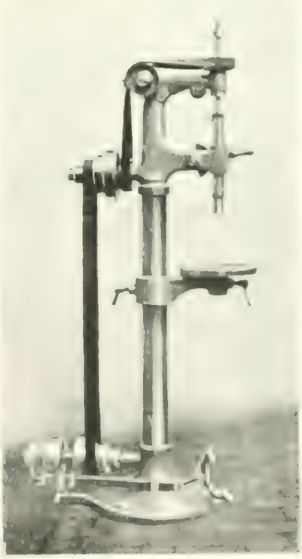

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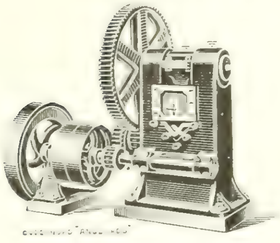

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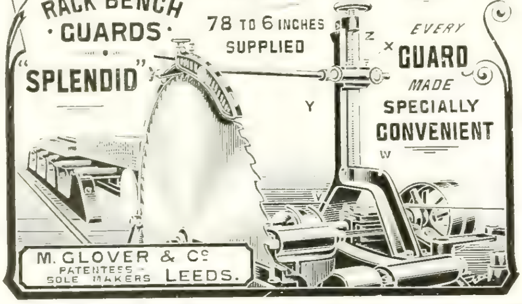

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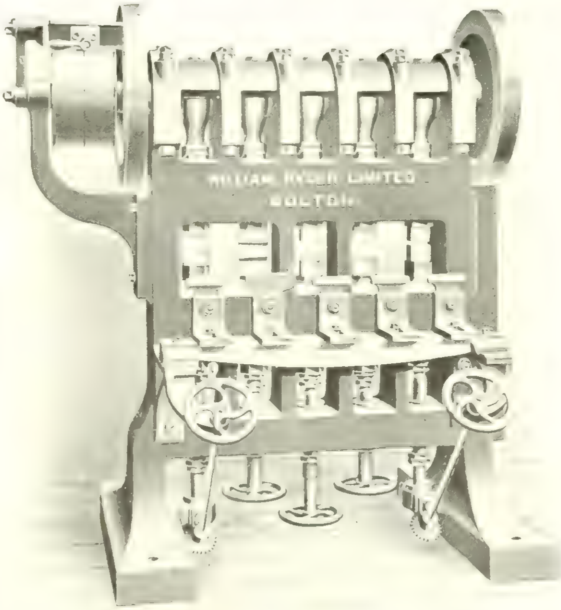

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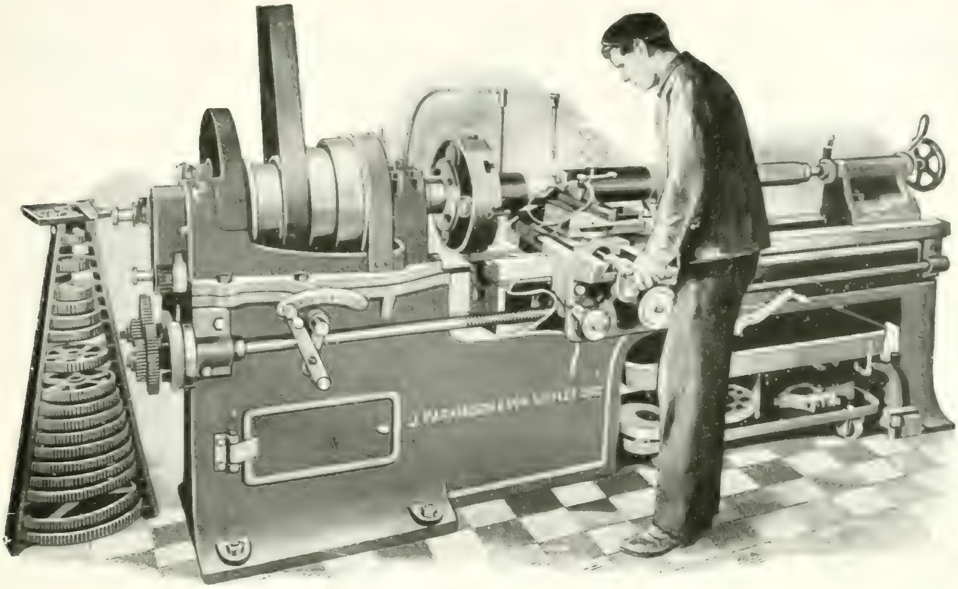

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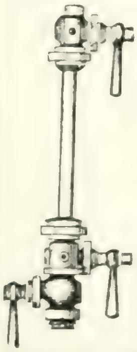

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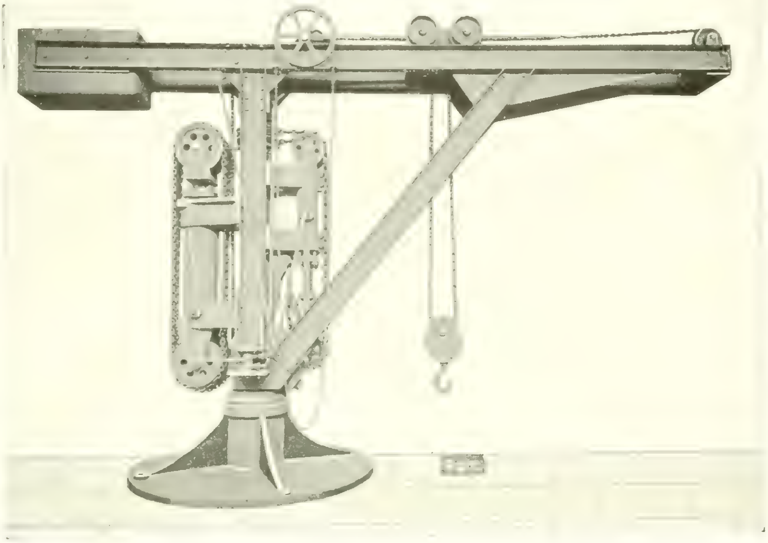

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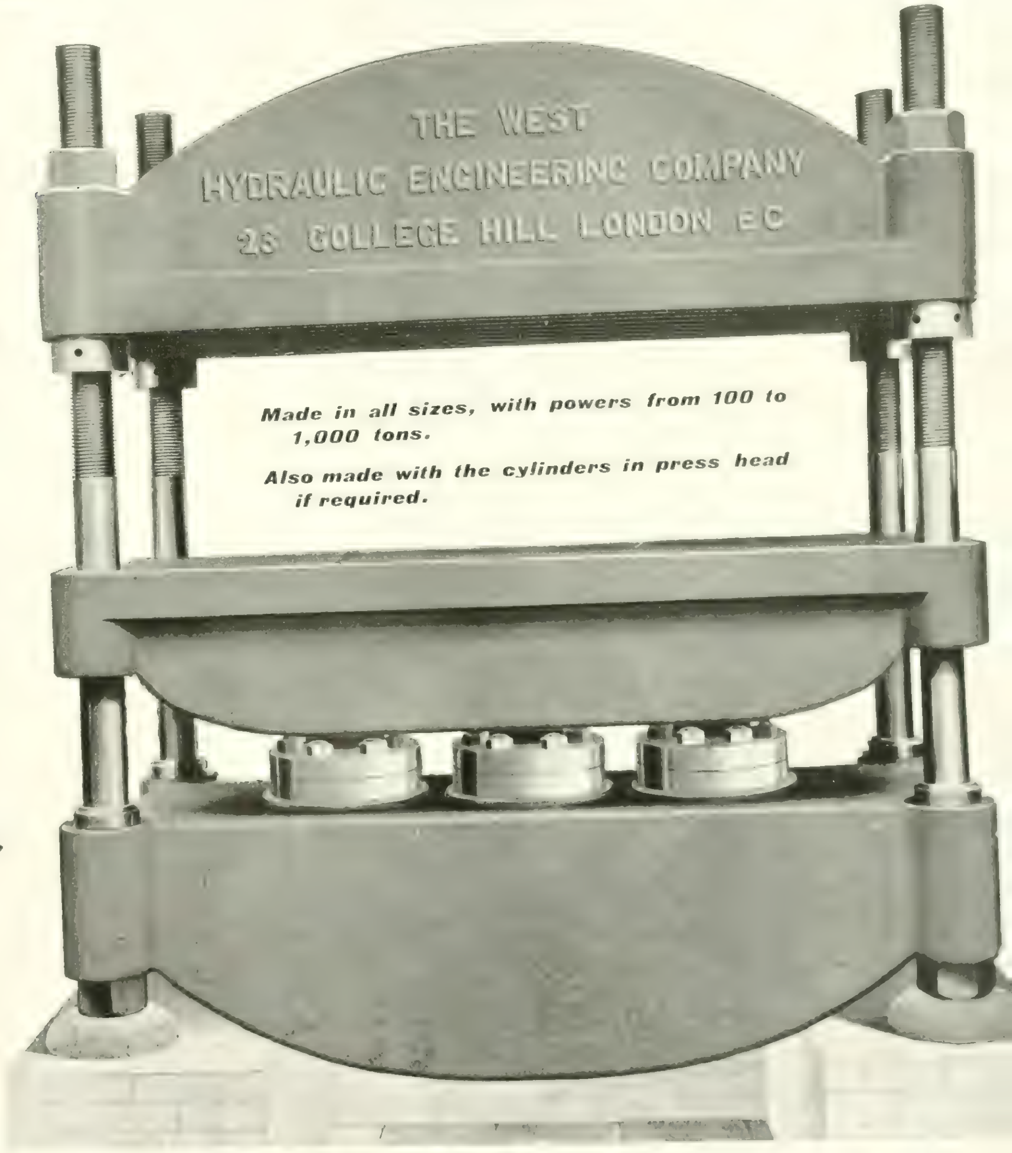

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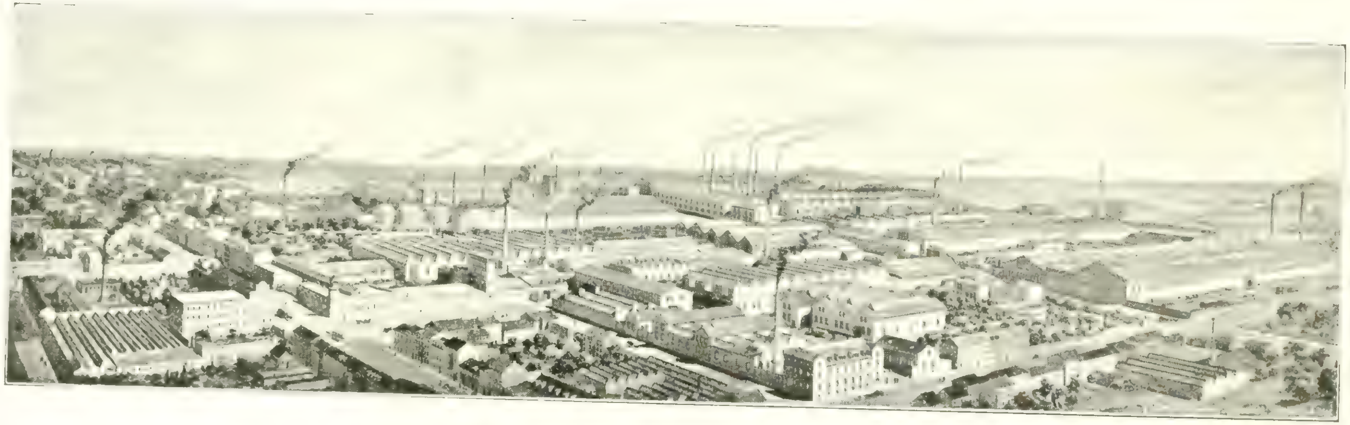

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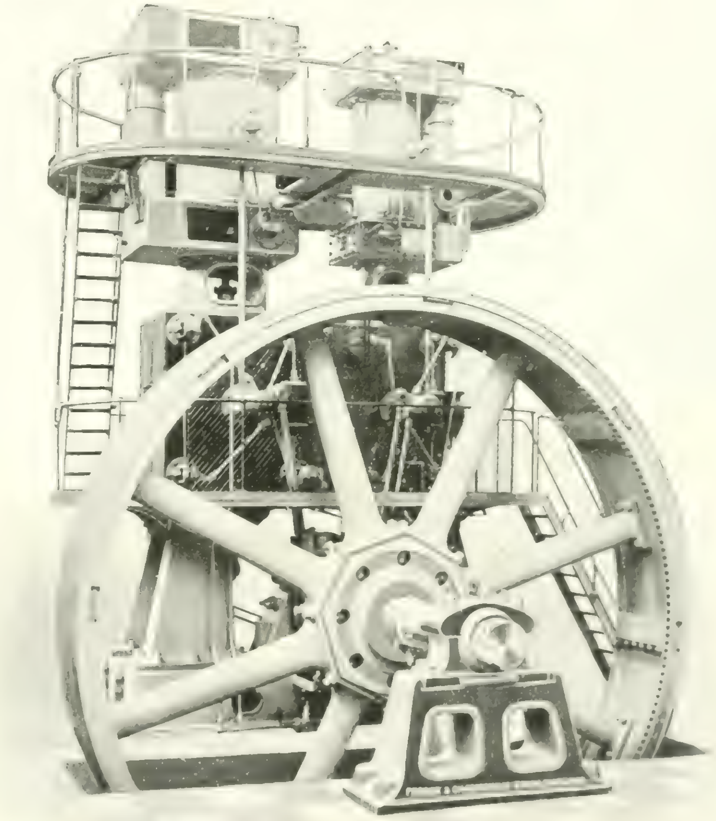

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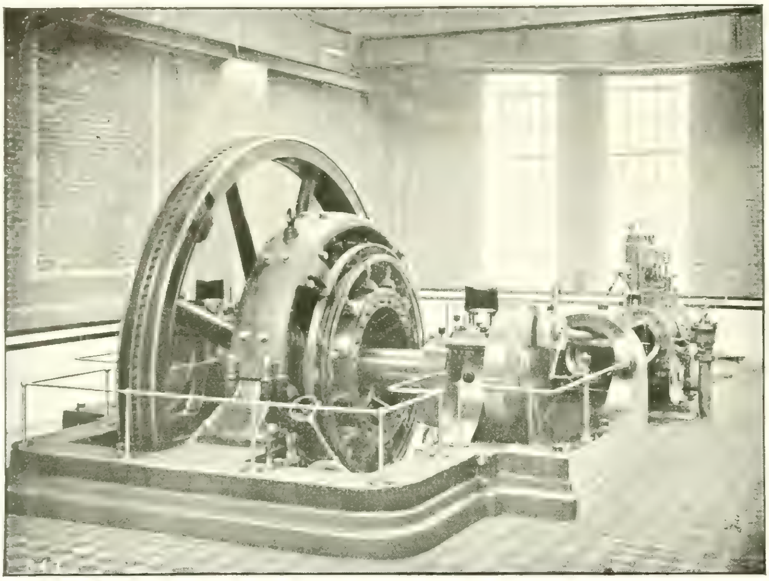

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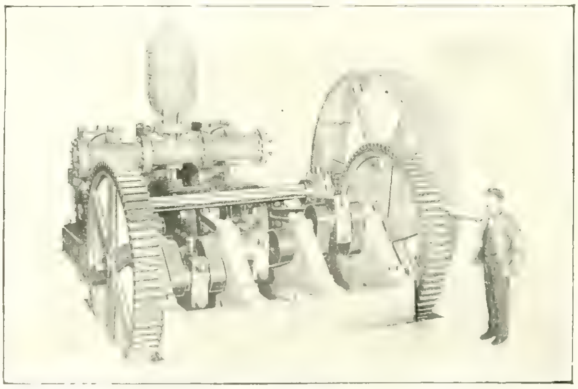

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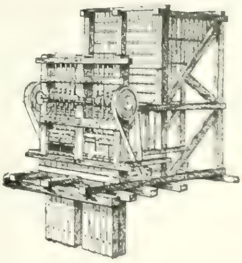

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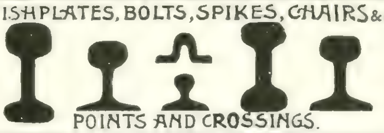

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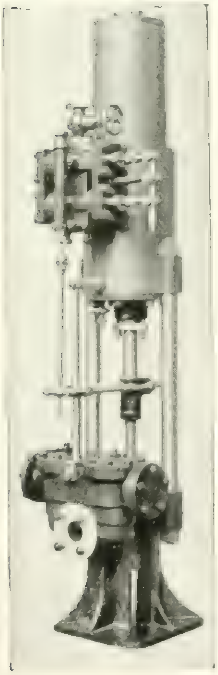

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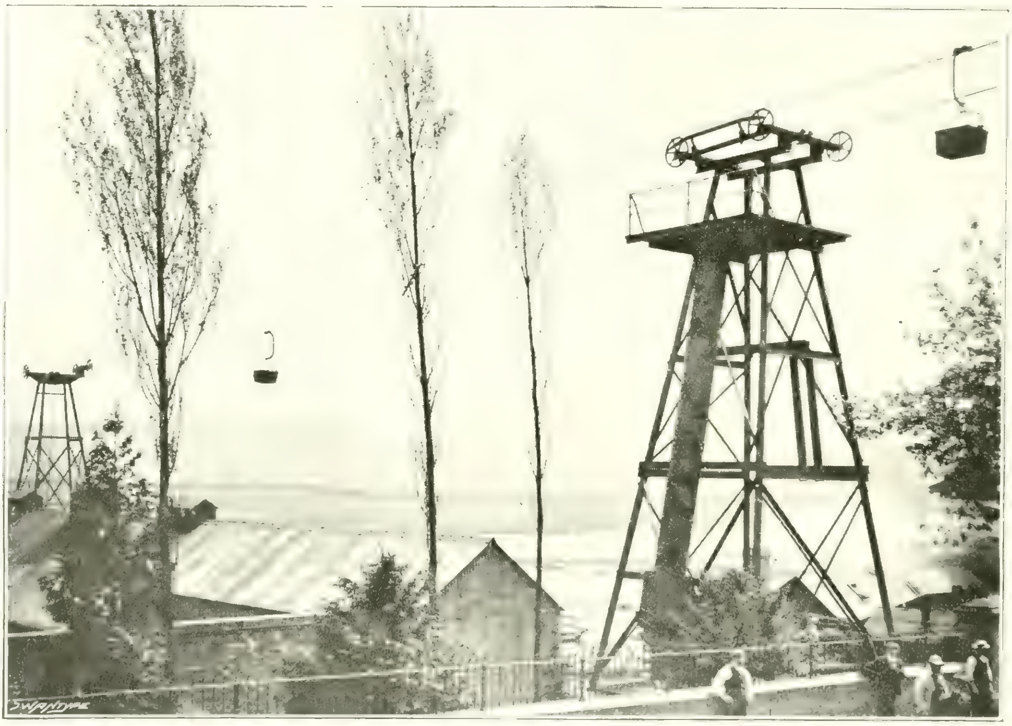

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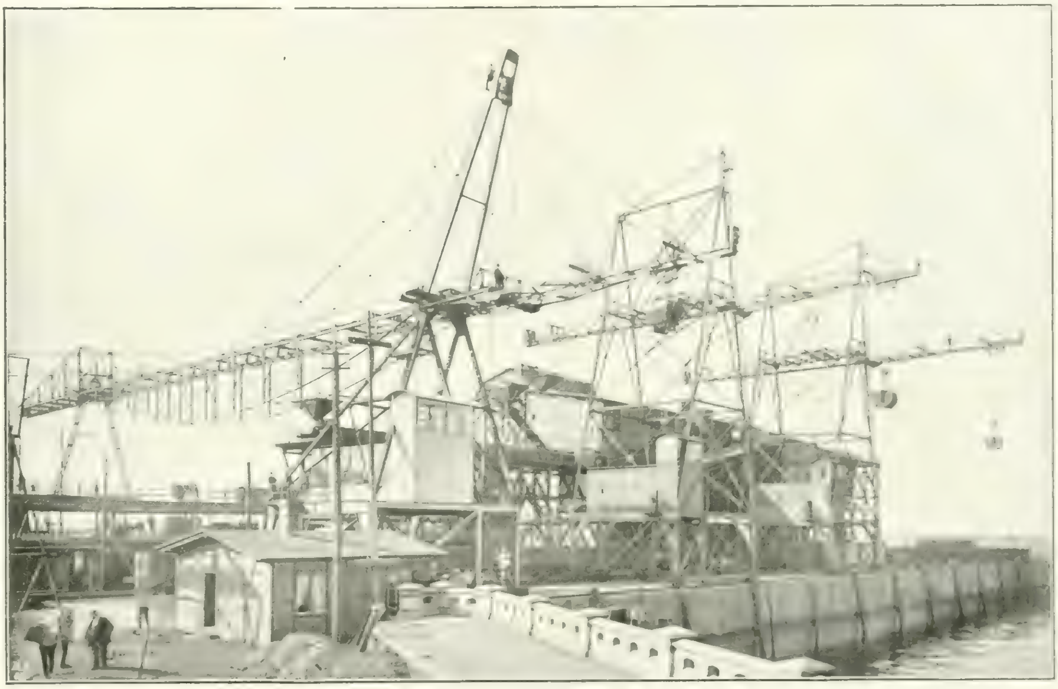

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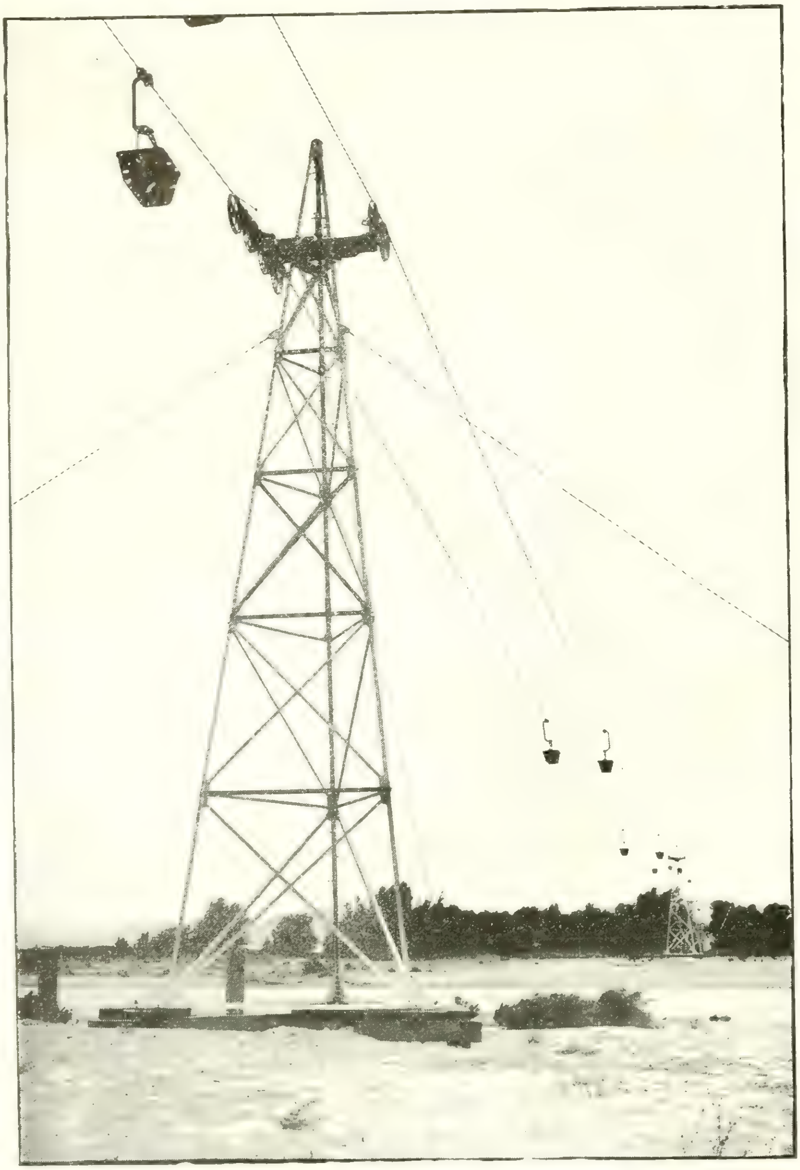

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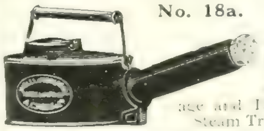

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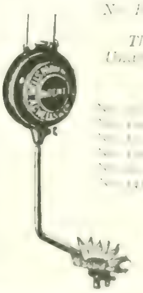

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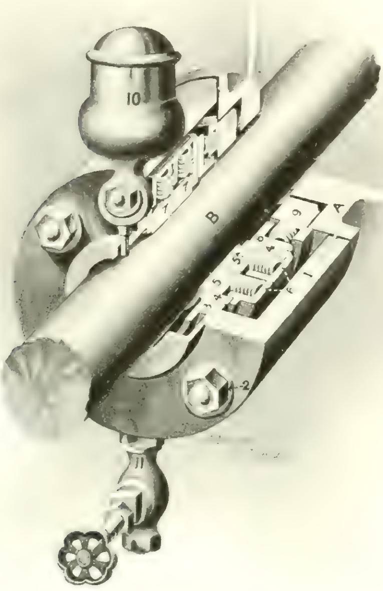

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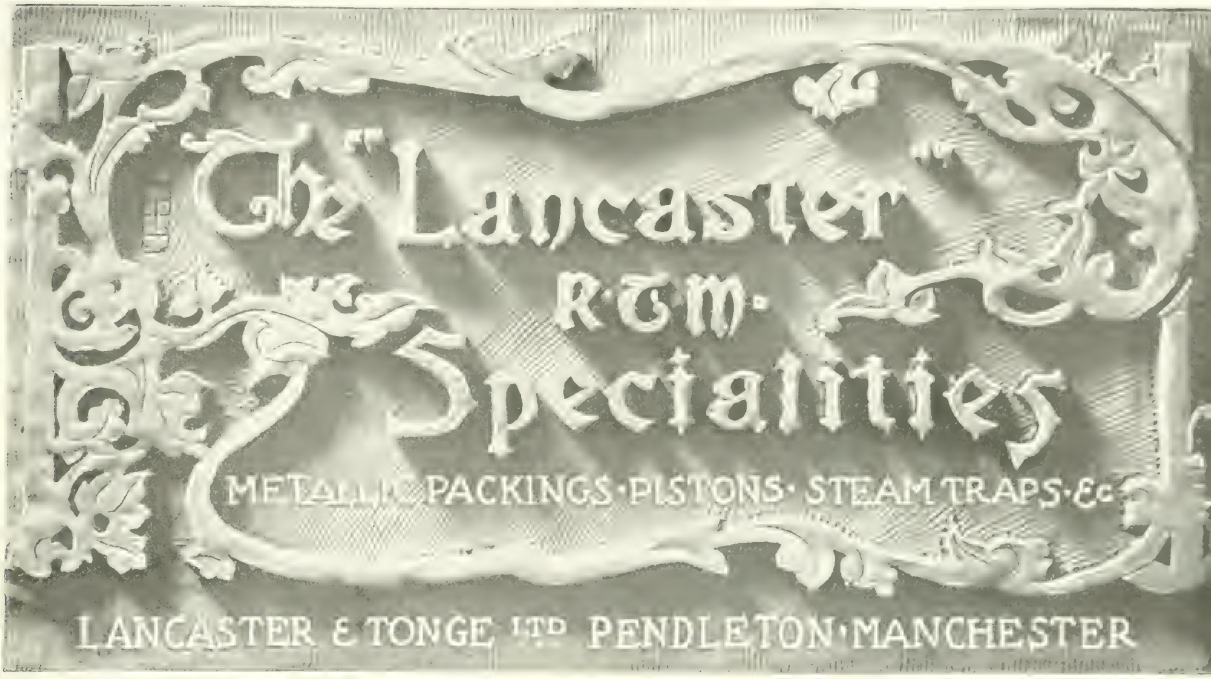

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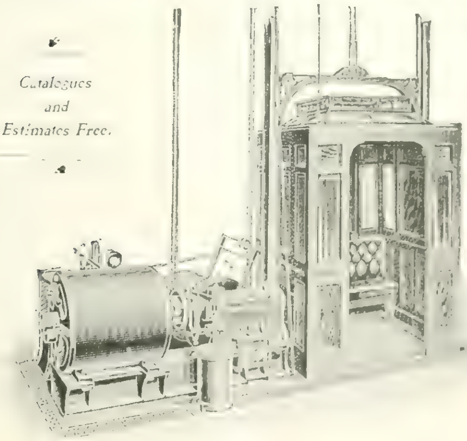

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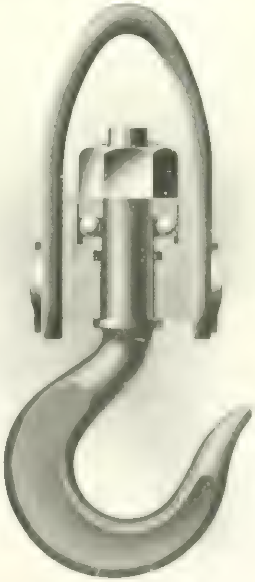

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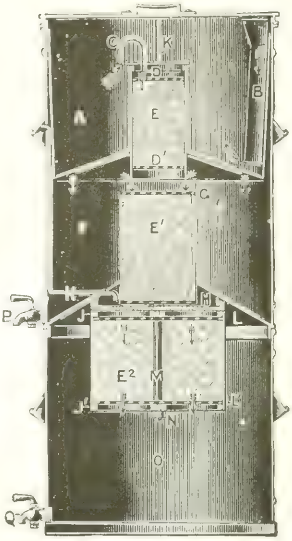

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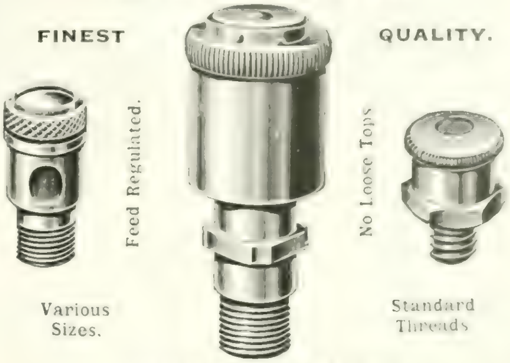
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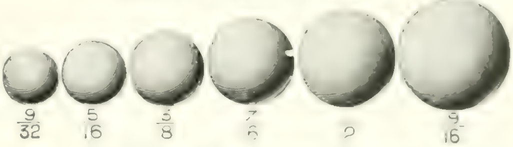

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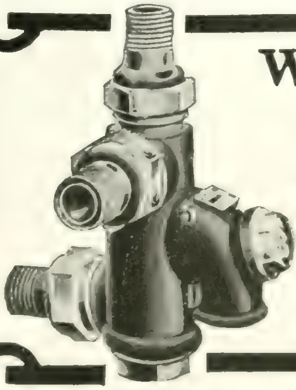

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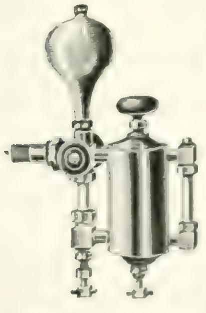

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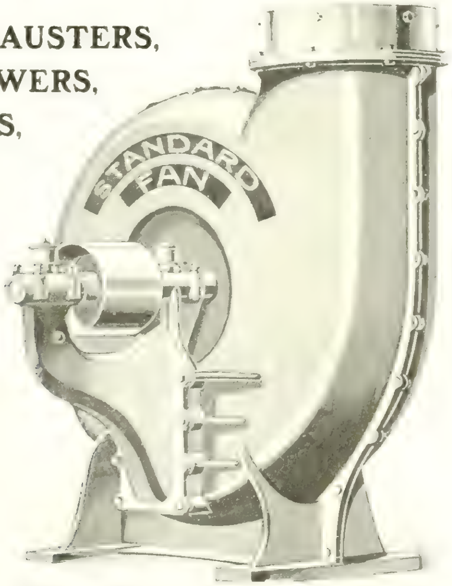

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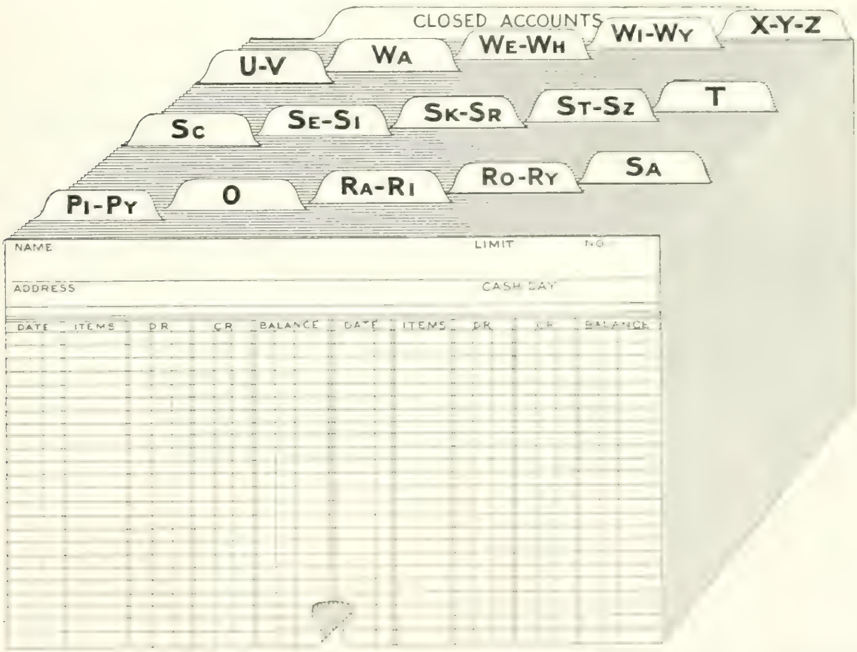

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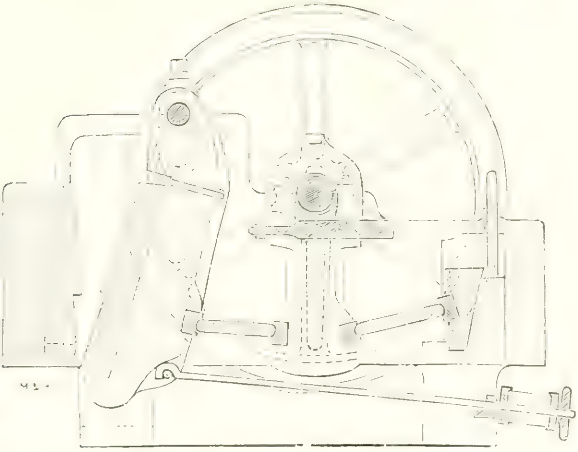

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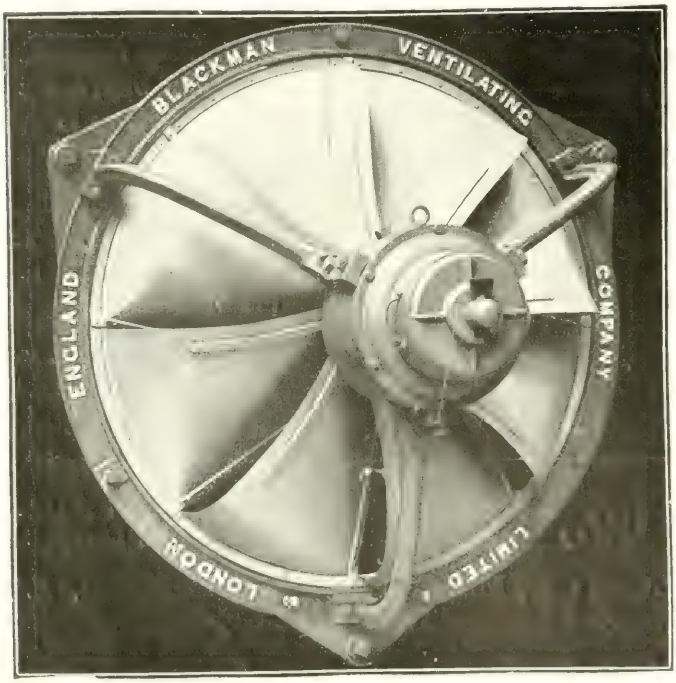

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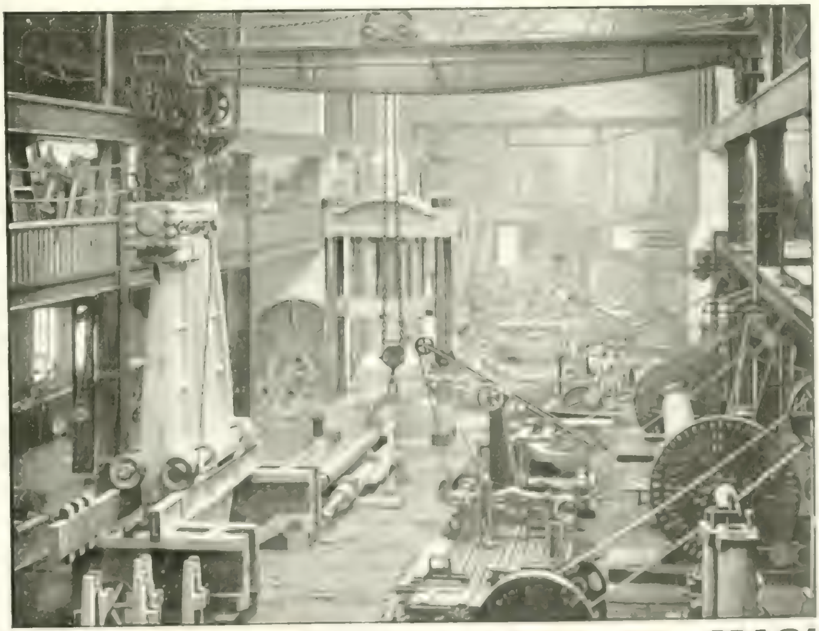

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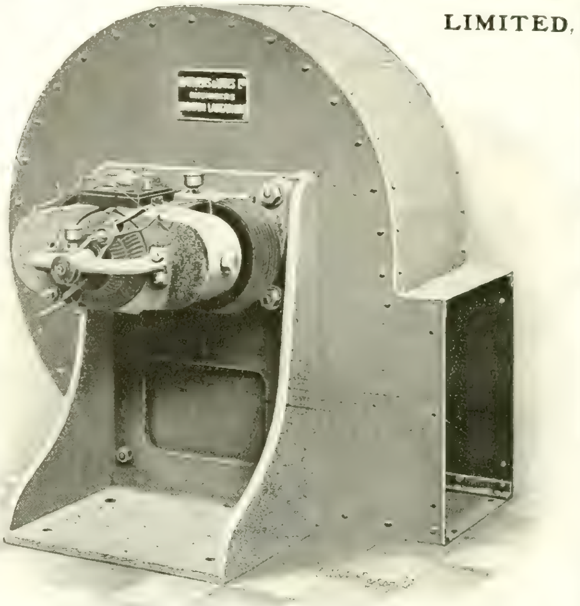

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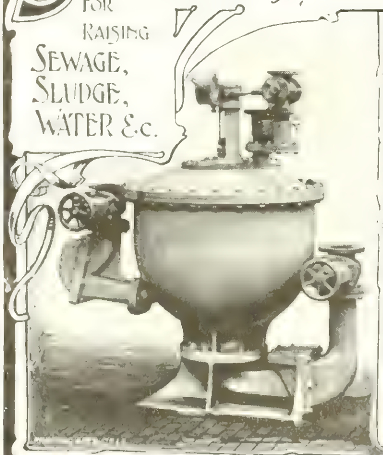

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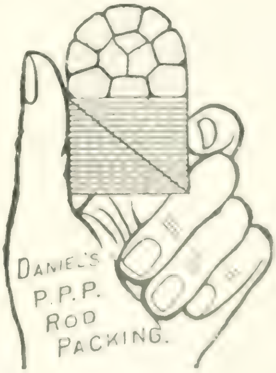

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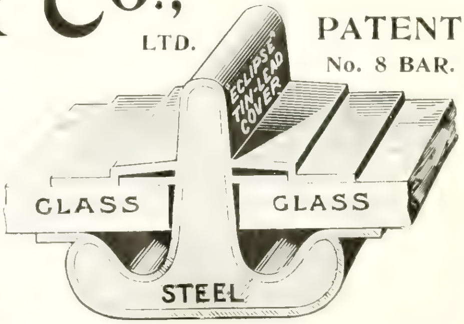

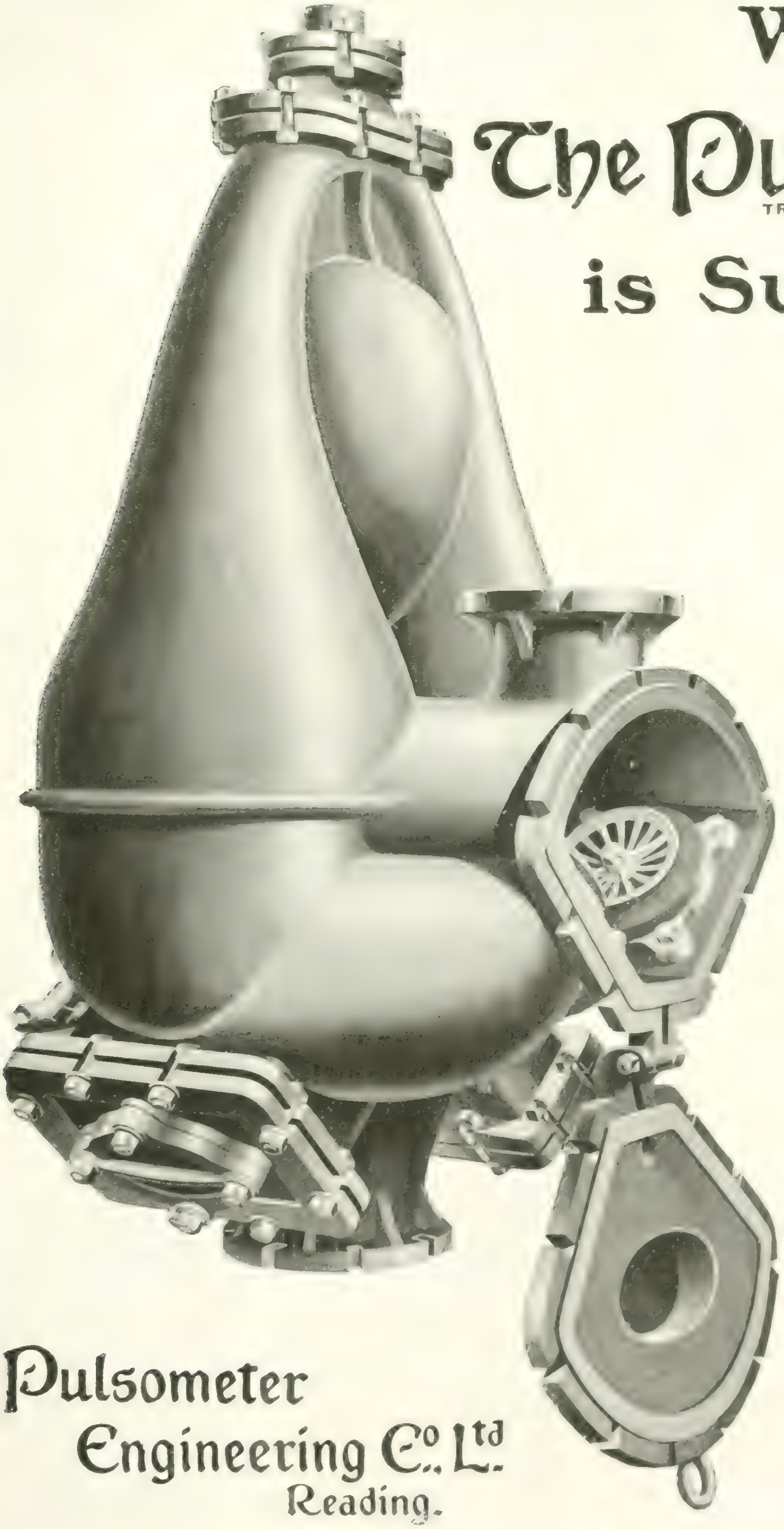

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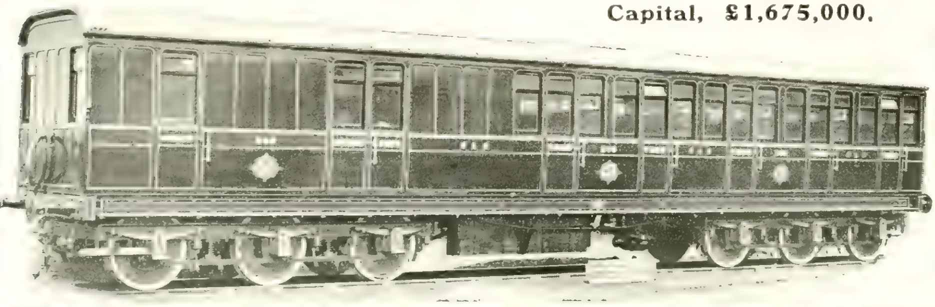

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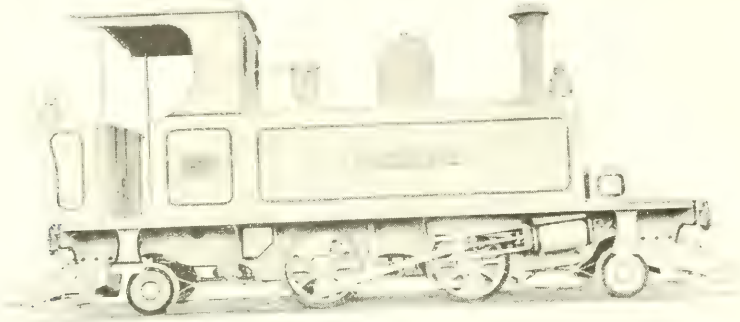

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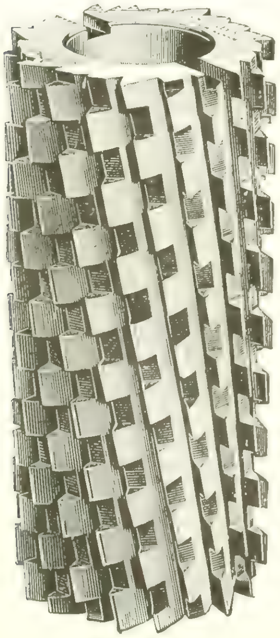

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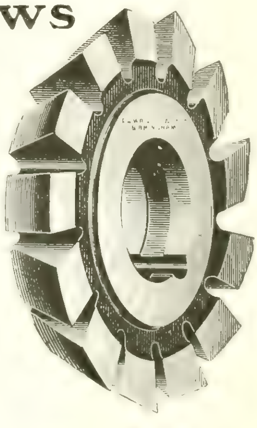

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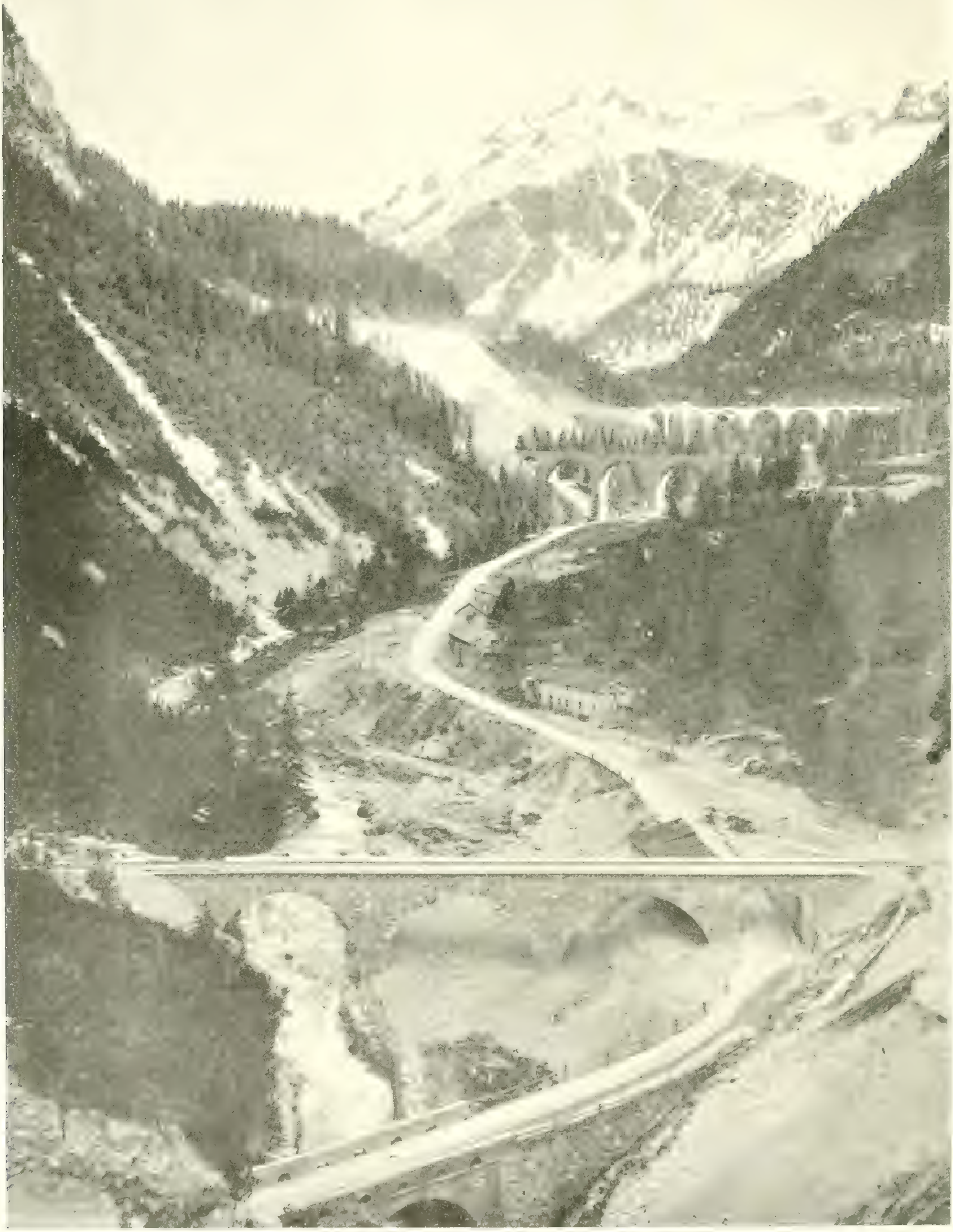

THE ALBULA-ENGADIN RAILWAY ABOVE BERGÜN.
Showing the First, Second, and Third Albula Viaducts
(See article on "The Albula-Engadin Railway.")

PAGE'S MAGAZINE

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A MICROGRAPHIC STUDY OF CAST IRON.

BY

PERCY LONGMUIR.

The distribution of the impurities in cast iron offers many features of interest to the engineer. The author briefly examines some typical cast irons, reproducing characteristic structures, and giving a few notes on heat treatment in the production of "black heart" and malleable cast iron.—ED.

AS a material of construction, cast iron has lost much of its former prestige, owing to the rapid advance of the Bessemer and Siemens-Martin methods of steel making. Nevertheless, in spite of its replacement by steel in many branches of the engineering profession, the total output of grey iron castings is by no means diminishing. Indeed, the output is an increasing one, for as the knowledge of cast iron increases new avenues for its application open out. Thus, in engine building practice, bearings of costly brass or gun-metal are being replaced by cast iron ones—which, lined with antifriction metal, give an equally satisfactory result. The facility with which good and clean castings may be produced, combined with a low cost of production, are great factors in favour of cast iron, to which must of course be added, the comparative ease with which subsequent operations of machining and finishing are carried out. Its chief disadvantage is the low resistance it offers to shock, or, in other words, its high brittleness.

All cast irons contain greater or less quantities of carbon, silicon, manganese, sulphur and phosphorus, the first element occurring in two distinct conditions, as free carbon or graphite, and as combined carbon. Very few cast irons met with commercially contain more than 95 per cent. metallic iron. It is, of course, the content of these impurities and their relationship to each other which determine the ultimate properties of the metal.

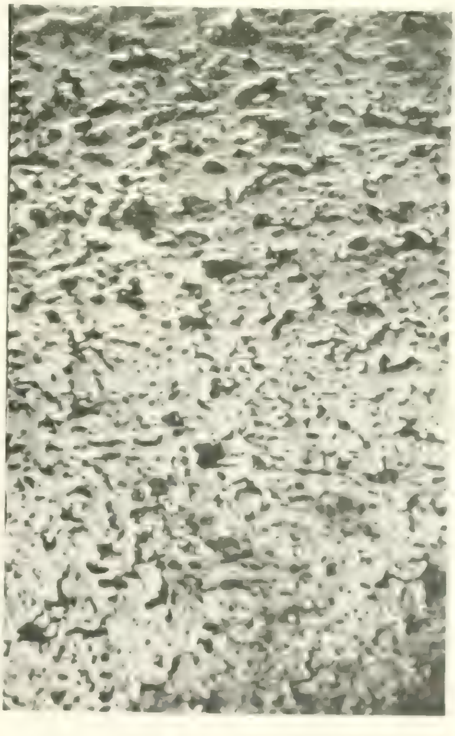

FIG. 1. [illegible]

Magnified [illegible] diameters.

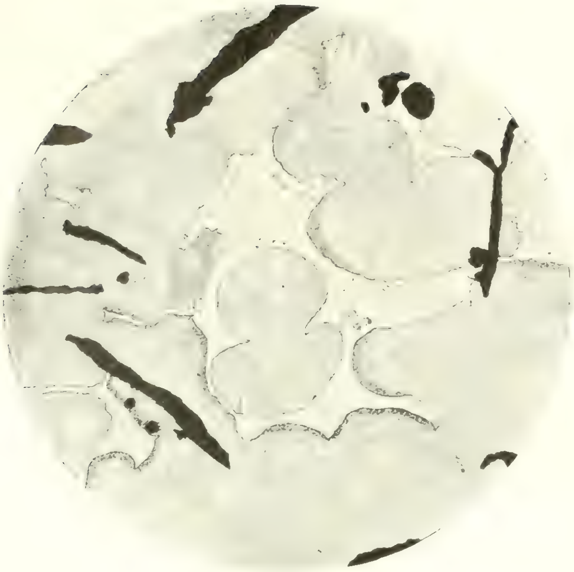

FIG. 2. GREY CAST IRON.
Magnified 230 diameters.

Microscopically, cast iron may be regarded as a mass of pure iron distributed through which are varying amounts of these impurities. A suitable analogy is found in the distribution of fruit through a cake, but still better is the original conception of Dr. Sorby, the distinguished founder of the science of metallography, who regarded a metal as one would view a crystalised igneous rock: granite, for instance, is a crystalised compound of felspar, quartz and mica, and offers many analogies to a metal which has crystalised from a molten condition.

Cast iron viewed under low magnification does not reveal its ultimate structure, but gives rather a general or bird's eye view of the structural arrangement, as shown in fig. 1. This is a photomicrograph of an unetched section of normal grey iron. To view the ultimate structure recourse must be had to higher magnifications, ranging from 200 to 500 diameters. The structure of a normal grey iron, magnified 230 diameters, is reproduced in fig. 2, and in it the black streaks and dots of graphite will readily be recognised. The elements present in cast iron, with the one exception of graphite, do not exist in an elementary state, but tend to form compounds with the iron, or with each other. Sulphur for instance, exists either as sulphide of iron or manganese, the particular sulphide being determined by the amount of manganese present. In certain cases, with a high sulphur and fairly low manganese, both sulphides may be present. Phosphorus forms, with the iron, a definite phosphide, and silicon in a similar manner forms a silicide of iron. Carbon not occurring free, is present in the form of either a carbide of iron or a double carbide of iron and manganese. The silicide of iron, which appears to be held in solid solution in the iron, cannot be differentiated microscopically, but with this exception, the compounds present are easily recognised, and have micrographically received distinguishing names. Thus, carbon present in the combined form is termed "cementite," which should represent a definite carbide of iron of the formula Fe_3C. However, all carbides are denoted by this term. Cementite may be present in a granular form, as thin plates or in fairly large masses. Pure metallic iron is microscopically known as "ferrite"—this term is also used in an elastic sense, for ferrite is also applied to siliceous iron—that is, iron containing silicon, but which, on etching, shows the characteristic crystal junctions of ferrite.

PEARLITE.

A mixture of cementite and ferrite is known as "pearlite." Pearlite may consist of

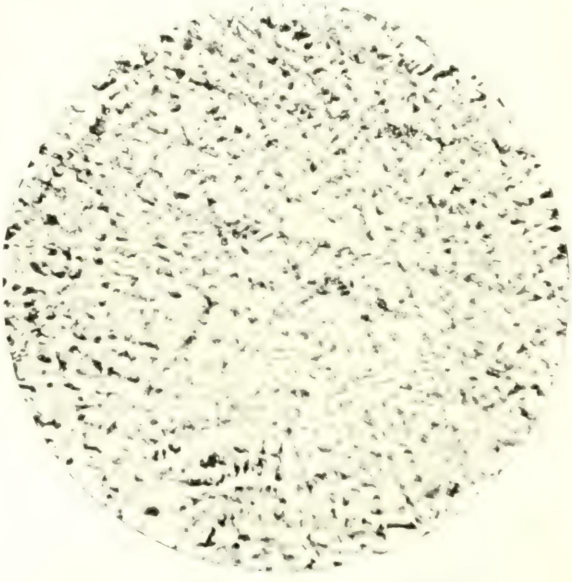

FIG. 3. WHITE CAST IRON—ETCHED.
Magnified 50 diameters.

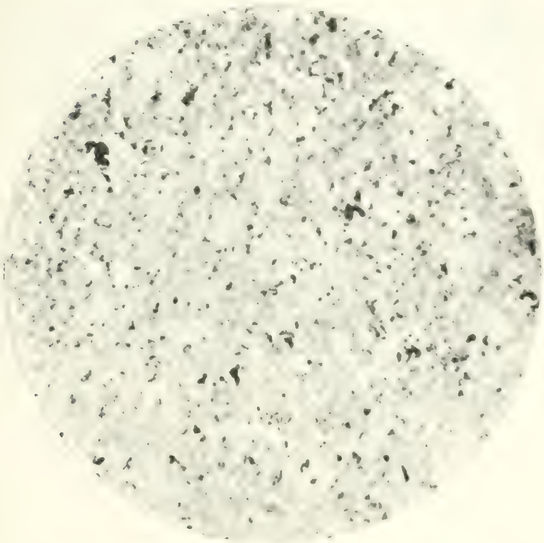

FIG. 4. AS FIG. 3, AFTER ANNEALING IN ORE.
Magnified 50 diameters

alternating plates of cementite and ferrite, thus presenting a laminated appearance, or it may consist of cementite embedded in ferrite.

The investigations of Professor Arnold have clearly shown that in an iron carbon steel containing 0·89 per cent. of the latter element, the structure consists entirely of pearlite, this point clearly marking the saturation point of iron for carbon. Above 0·89 per cent. carbon the structure consists of pearlite and cementite. However, in the grey irons familiar to the foundries, the content of combined carbon is always well below the saturation point, hence their structures, as far as carbon is concerned, consist essentially of pearlite and graphite. Conversely, the structure of white irons is built up of pearlite and cementite.

COMBINATIONS WITH PHOSPHORUS.

Iron and phosphorus are naturally associated with the name of Mr. J. E. Stead, F.R.S., whose masterly research on this subject opens out a fund of direct information to the user of cast iron. Briefly, phosphorus present in cast iron exists as a definite phosphide held in an eutectic. "Eutectic" for our purpose may be defined as solidified mother liquor, which represents the last portion of an alloy to solidify. This eutectic containing the phosphorus is very readily recognised in grey irons by ordinary etching mediums, but in white irons to distinguish it from the cementite the heat tinting process described by Mr. Stead becomes necessary.

GRAPHITE.

Turning again to fig. 2, the first thought arising in the mind of one accustomed to fracture examination of cast iron, is the comparatively small amount of graphite present. This is readily explained by the fact that in breaking cast iron the route of the fracture follows the graphite plates, the broken surface thus showing many graphite cleavage planes. A micro-section is cut from a mass of the metal, hence, instead of following these cleavage planes, the flakes of graphite are themselves cut through, and when viewed microscopically are seen as curved or straight black lines, or rounded dots as the case may be. The pearlite of fig. 2 is laminated in a few places, but the majority of it is granular in form. The large irregular network in the centre, completely enclosing an area of pearlite, represents the phosphide eutectic. There are several smaller areas of this eutectic easily distinguishable from the surrounding pearlite.

STRUCTURE OF PURE CAST IRON.

From the foregoing it will be seen that the structure of a very pure grey cast iron, that is, one having low contents of combined carbon, manganese sulphur and phosphorus, would consist of siliceous ferrite broken up by plates of graphite. As the content of graphite decreases that of combined carbon increases, and with it the amount of pearlite until a

FIG. 5. [illegible]

point is reached when the structure is chiefly composed of these two constituents. Above this point, as the combined carbon increases the graphite correspondingly disappears, and is replaced by massive cementite, until finally a white iron containing no graphite and built up of pearlite and cementite is reached.

WHAT ARE THE MOST SUITABLE STRUCTURES FOR SPECIFIC PURPOSES?

Many tons of castings are made whose chief requirement is that they machine up "dead soft." The structure of such an iron, to meet this one requirement, should consist of siliceous ferrite broken up by plates of graphite, with an amount of pearlite present equivalent to 0·2 per cent. combined carbon. Owing to the high graphite such a structure would not behave well under tensile, transverse or compression tests, but owing to the comparatively small amount of pearlite it would machine with comparative ease.

This question of machining must bear largely on any consideration of cast iron from an engineering point of view. Thus, whilst with special tools white cast iron may be turned or drilled, the cost of such work is necessarily high in comparison with the grey irons. Therefore, the combined carbon limit of cast iron is here taken at 1·0 per cent, which would represent a structure consisting of pearlite, graphite, and a little massive cementite. Such a structure, though hard, would represent a cast iron just within the limit of economical machining, and would also represent an iron capable of meeting a high compression test. An iron possessing such a structure would be very suitable for castings having hydraulic or steam pressure to withstand, provided these castings had to undergo only a minimum amount of machining.

The highest tensile and transverse tests would be met with in a structure consisting of pearlite with—for cast iron—the minimum amount of graphite and phosphide eutectic. Such a structure would also be suitable for the ordinary run of cylinders and covers, valve bodies and general hydraulic fittings.

It will be readily seen that in this range of structure, from one of ferrite broken up by graphite to one of pearlite and graphite containing traces only of free cementite, any variety of product within the limits of cast iron may be readily obtained, and an intelligent use of microscopical methods of examination will result in the selection of suitable irons for specific purposes. A strong aid to this selection is found in the fact that cast irons invariably follow certain laws. Thus, as already mentioned, in a series of ascending irons, as the graphite decreases pearlite increases, until a point is reached at

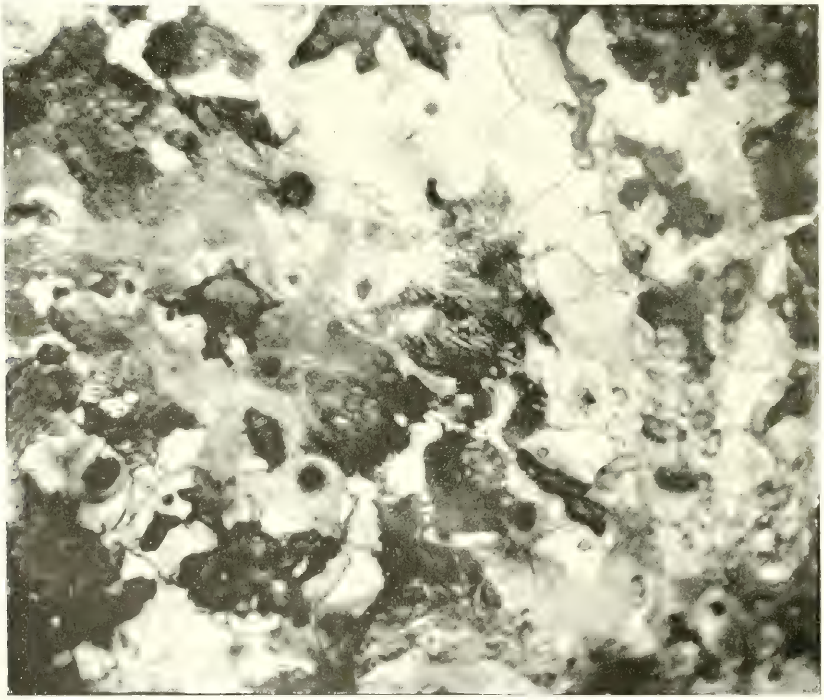

FIG. 6. MICRO-STRUCTURE OF "BLACK HEART" CASTING.
Magnified about 300 diameters

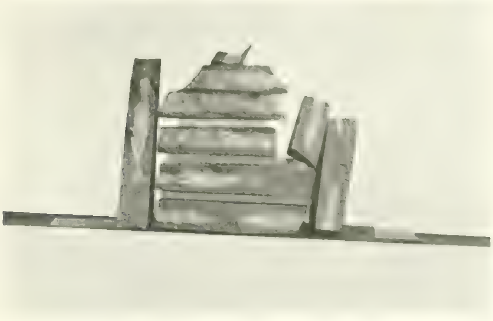

FIG. 7. FRACTURES OF WHITE CAST IRON.
Showing Grey Edges.

which cementite appears structurally free, and then, as the irons approach the white variety replaces graphite altogether. Similarly, when the phosphide eutectic or sulphide globules are present in small completely isolated areas, their effect is comparatively harmless, but when the phosphorus or sulphur are present in quantity sufficient to give compounds forming a network through the structure, evidently the danger limit of these elements has been exceeded. Such a brittle network—when translated into the solid—will form a series of connected membranes very favourable to the passage of fracture, and therefore microscopical examination would warn the user to put such an iron only into castings in which brittleness is immaterial.

THE FURTHER TREATMENT OF CAST IRON.

Cast iron readily lends itself to heat treatment, as shown by the fact that a strip of white iron, showing no bend and a strong tendency to fracture, may after suitable annealing be made to bend through an angle of 90 deg., or, in certain cases, through one of 180 deg.

It has been already shown that cast iron containing massive cementite is beyond the ordinary machine limit, and such castings are inadmissible in the general run of engineering products. Fig. 3 shows a typical structure of white cast iron, that is, consisting essentially of cementite and pearlite. The metal of which this structure is typical represents a tenacity of from nine to twelve tons per square inch, and a hardness quite beyond the reach of ordinary tool steels. Fig. 4 shows the structure of the same iron after annealing in ore by the method practised for the production of malleable cast iron. This photomicrograph consists essentially of pearlite interspersed through which are a few small patches of graphite. The mechanical value of such a structural change is shown by the fact that the tenacity of fig. 4 is now equal to twenty-seven tons per square inch, with an extension of 6·5 per cent. on two inches, and a contraction of area at the point of fracture of 10 per cent. Further, the metal may now be machined with ease by

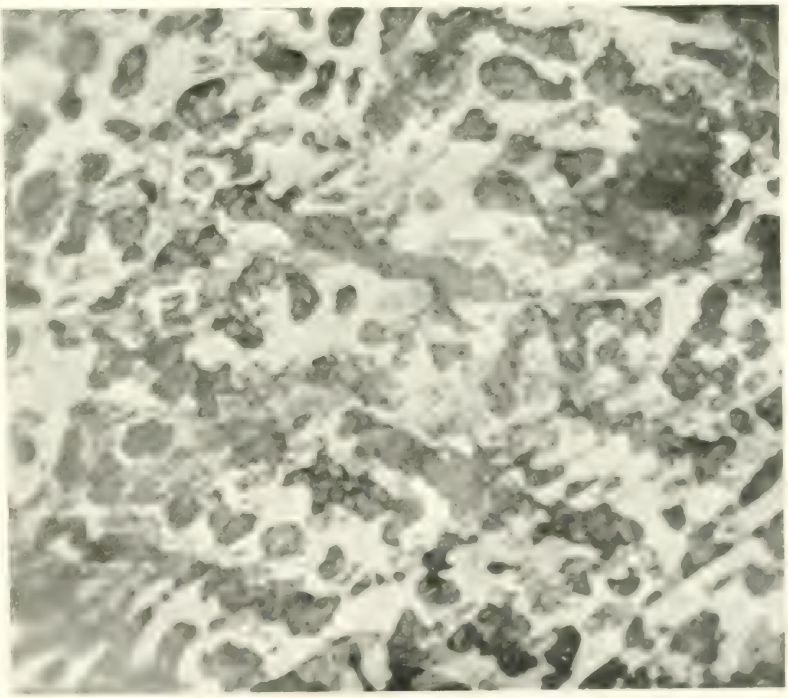

FIG. 8. [illegible]

Magnified about 100 diameters.

ordinary tools. The technical details of the annealing process are hardly within the scope of our present subject. They may, however, be briefly described as follows. The white iron castings are packed with an oxidising material, such as iron ore or mill scale, in iron pans. These pans are placed in a furnace termed an annealing oven, and given a prolonged heating. At the necessary temperature the oxygen of the iron ore combines with the carbon of the white iron, and gradually effects its removal. The carbon removal is effected as follows:—

$$C + O = CO.$$

Should it take the form of—

$$C + O_2 = CO_2,$$

the castings will be very much scaled by the action of the carbonic acid.

The carbon removal is slow, and therefore the thicker the casting the greater the time occupied by the annealing process, average castings taking from five to ten days. This process is the converse of the cementation method of carburising iron, and as in the cemented bars the outside layers are richest in carbon, so in malleable iron castings the outside layers contain the least carbon; this element gradually increasing towards the centre of the casting. Thus, a section of malleable iron will give an outside ring of oxidised iron, an inner ring of siliceous ferrite, a second ring of ferrite and pearlite, the pearlite increasing in quantity towards the centre. If the annealing has been sufficient, no cementite should appear, but in castings insufficiently annealed much graphite may be present in the centre.

Massive cementite in white cast iron may be decomposed into graphite and ferrite by annealing out of an oxidising atmosphere, followed by slow cooling, a method largely followed in the production of " black heart " castings. By annealing in an oxidising atmosphere the greater part of the carbon is removed; by annealing white iron for the production of " black heart " the carbon is not removed, but simply changed in form. The method followed in practice is very similar to that for the production of malleable cast iron. The castings of white iron are annealed for a given length of time by heating to about 850 deg. C., and slowly cooling down to 650 deg. C. These castings possess a wide industrial application, and a large trade—particularly in the States—has been developed in their production. A photograph of a few typical fractures of small " black heart " castings is shown in fig. 5, and the light edges and dark graphitic centres will be readily noted. Microscopical examination of this product shows that it is built up of ferrite, pearlite and graphite, as is well shown in fig. 6. The crystal junctions of the ferrite in fig. 6, may be readily recognised; the dead black areas are graphite, and the remaining portion pearlite. This structure may be described as an ideal one for cast iron, its tenacity is good, its degree of softness and general working properties exceptionally so, and within limits the metal may be bent through a fairly wide angle. The general properties of " black heart " castings, as indicated by microscopical examination, place them midway between soft grey iron and malleable cast iron.

An interesting example of partial annealing in the case of white cast iron is shown in fig. 7, which reproduces a few fractures of grey iron containing a central core of white iron. Here the heat has evidently been insufficient, or of too short a duration to decompose the whole of the cementite. The grey portion microscopically examined revealed every characteristic of a phosphoric grey iron, whilst the typical cementite and pearlite structure of the central core is reproduced in fig. 8. This example is very telling, as showing the susceptibility of cast iron to heat treatment, but it is also most emphatic in showing that both time and temperature are required to effect the complete decomposition of the cementite.

The structures given sufficiently indicate the scope of microscopical analysis when applied to cast iron. A thorough co-ordination of structure with chemical analysis and mechanical properties will lead the way to fuller knowledge of a metal which in more senses than one forms the foundation of many engineering enterprises.

For the loan of the negatives illustrating figs. 3 and 4, the author is indebted to the courtesy of his friend, Mr. T. Baker, B.Sc.

THE EQUIPMENT OF THE ROBINSON MINE, JOHANNESBURG.*

BY

EDGAR SMART, A.M.Inst.C.E.

Our Johannesburg Correspondent, continuing his survey of mining practice in South Africa, deals with some of the most notable features of the Robinson Mine—one of the largest on the Rand—and with the aid of specially taken photographs, brings out many points of practical utility to the miner. The subject will be continued in the following number.—Ed.

I

EARLY WORKING.

THIS property is not only one of the oldest on the Rand but also one of the largest of the outcrop mines; at the present time it includes more than 260 acres. As with many of the early propositions on which work was started before the real extent and continuity of the ore bodies of the Main Reef series had been proved, the Robinson mine commenced operations in 1887 in a very humble manner. A 10-head battery with 750-lb. stamps was erected, the ore for which was at first supplied from open trenches on the outcrop of the reefs, and very soon after an adit level was driven to open up the reefs systematically.

The total length of reef included in the property along the line of strike is 3,716 ft., and in 1889–90 three main vertical shafts were sunk as well as several prospecting shafts at intervals along this length. A 40-head mill of 850-lb. stamps was erected, which was increased to 60-head in 1891, at which time also Frue vanners were introduced, and the cyanide process was applied to the treatment of tailings.

The first compressor plant on the mine was also put down in 1891, an average of eleven drills being at work on development during that year.

INCLINE SHAFTS

In 1892, owing to the gradually lessening inclination of the formation, which with vertical shafts would have necessitated very long cross-cuts to intersect the reefs at the lower levels, it was decided to work the mine in future by incline shafts. No. 1 main vertical shaft was, at a depth of 303 ft., was turned into an incline, and by sinking from that point and rising from each of the upper levels the incline shaft was completed from the surface to the sixth level ([illegible] ft. on the incline or [illegible] ft. vertically) in about ten months. This shaft starts from the surface at the outcrop of the main reef and main reef leader, which are very close together, and has an inclination of [illegible] deg. for [illegible] ft. of its length. At this point and again at others lower down, the angle is decreased in order to follow as nearly as possible the course of the reefs which have been thrown upwards at several places by dykes.

No. 2 main incline shaft, on the eastern part of the property, was commenced in the same year. Both of them are [illegible] ft. by [illegible] ft. clear, and are divided into three compartments,

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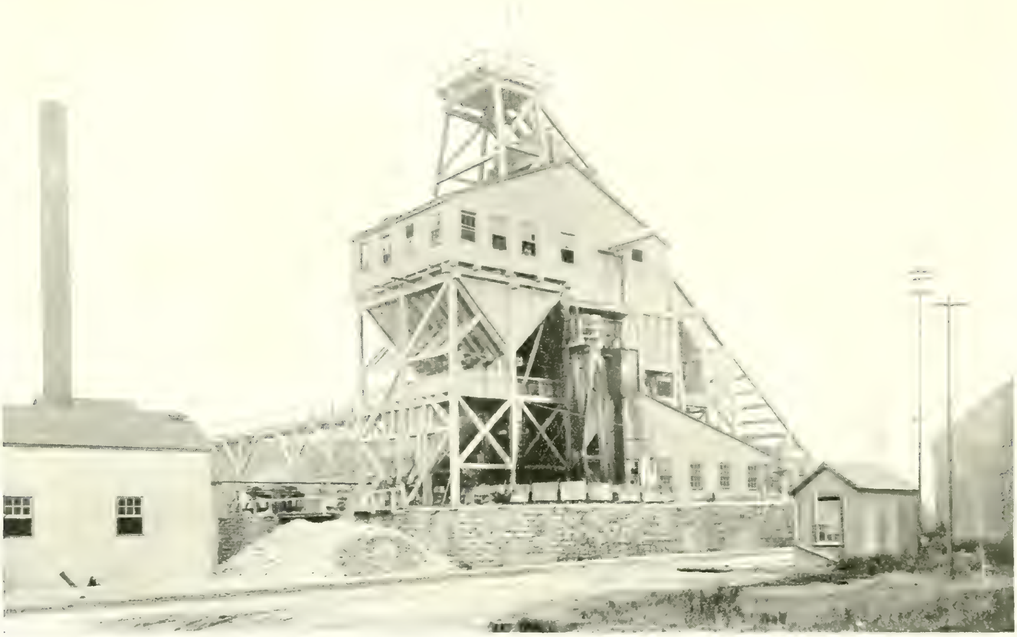
* In presenting this account the author wishes to acknowledge the courtesy and kindness of the general manager of the mine, Mr. H. B. Price, the Company's engineer, Mr. B. Gray, and the former assayer, Mr. W. W. Ward, who in addition to the members of the staff mentioned have countenanced and assisted in the assembling and arrangement of the various data.



[illegible] FIG. 2. HEADGEAR AND SORTING HOUSE, WASTE ROCK DUMP, AND ENGINE HOUSE AT NO. 1 MAIN INCLINE SHAFT.

two for hoisting and one for man-way and pumps. They averaged in cost about £9 per foot, including a double track laid with 40 lb. rails. At the end of 1902 these two shafts had attained the depths of 1,844 ft. and 1,462 ft. respectively, measured on the incline.

Near the centre of the property the reefs are intersected by a large dyke varying from 240 ft. to 280 ft. in thickness, whose direction is a little to the west of south, that is to say, nearly at right angles to the strike of the reefs. At the surface the dyke dips 45 deg. west, and in the lowest levels at present opened it has turned over and dips about 3 deg. to the east. As far as underground work is concerned, therefore, the property may be considered almost as two separate mines, for it is obviously undesirable to drive through the dyke any more often than is necessary. The two main shafts are, however, connected through the dyke on the fifth and twelfth levels.

As about two-thirds of the ore remaining in the mine is situated on the eastern side of this dyke, it has been decided to fully equip No. 2 incline as a main hauling shaft. The recent increase of the mill to 200 stamps requires facilities for sorting and breaking 25,000 tons of rock monthly, instead of 18,000 as hitherto, and for this reason a new sorting and breaking plant is also to be included in the new equipment of No. 2 shaft.

In the first place the shaft has been made 8 ft. 6 in. wider, to provide five compartments instead of three; two of these will be used for lifting ore and water by means of a Whiting hoist and two other compartments will serve for men, tools and general supplies, the present hauling engine being utilised for these purposes. The Whiting hoist will operate 5-ton skips for ore and 1,200-gallon tanks for lifting water, the latter having a bottom valve with automatic discharge; the change from one pair to the other can be made very quickly. It is intended as far as possible to haul water chiefly at night and ore by day, so as to have the advantage of sorting by daylight, which is preferable to the electric light for this purpose. Belt sorting gear and Blake-Marsden crushers will be used here.

To provide against future deficiency of native

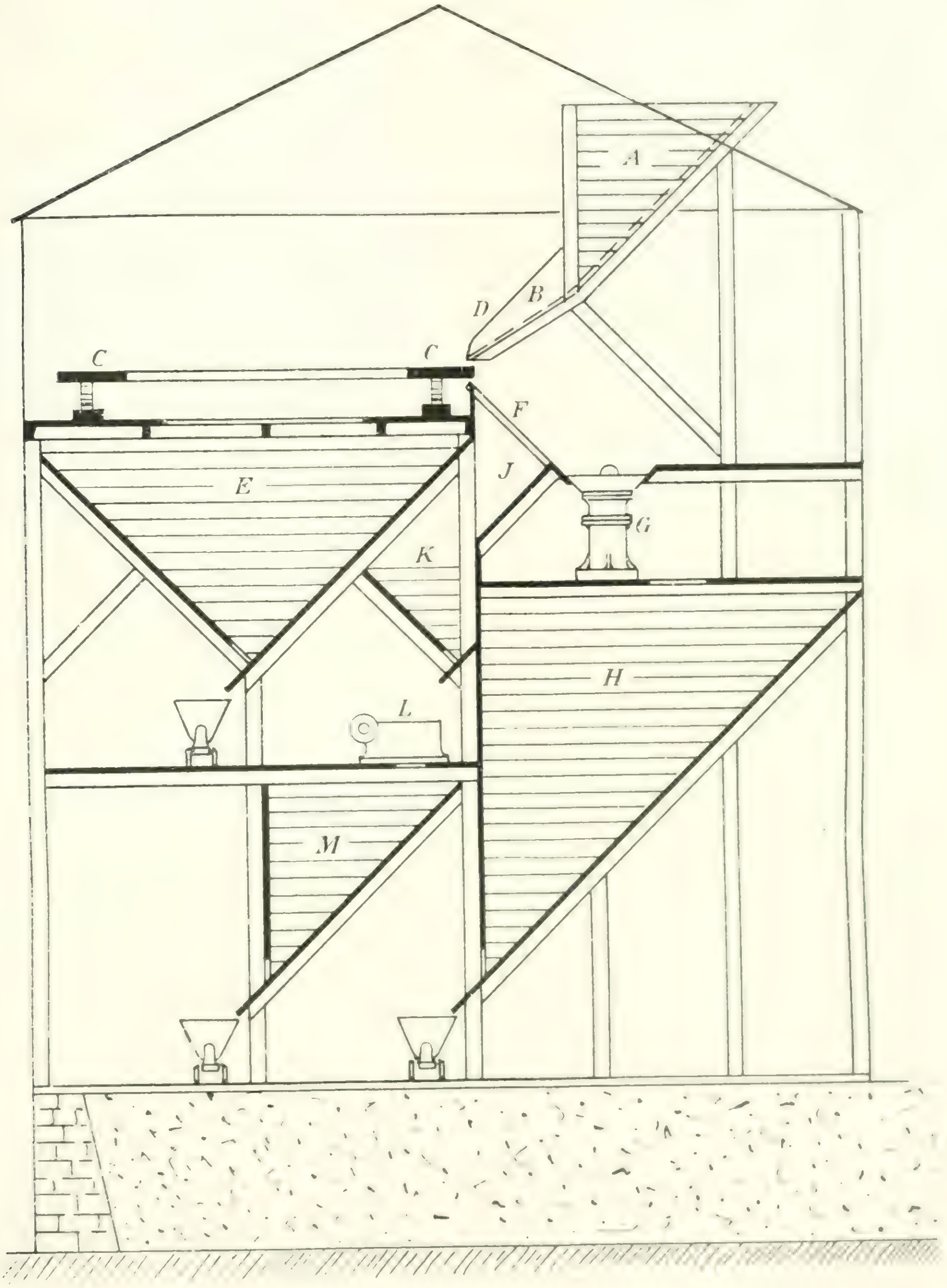


FIG. 1. VERTICAL SECTION THROUGH SORTING HOUSE.

labour in the stopes, a 65-drill compressor plant will also be installed at this shaft, which together with the plant referred to later on, will make the total compressed air available on the whole mine equal to the requirements of 100 drills as well as the subsidiary pumps used when sinking. The whole of this new plant for No. 2 shaft is being supplied from the Erith Works of Messrs. Fraser and Chalmers.

At the tenth level of both east and west main shafts there is a three-throw plunger pump, with a capacity of 6,000 gallons per hour, and at the sixth level in No. 2 east shaft there is a double plunger horizontal Reidler pump, all of these being electrically driven from the transmission plant in the main power station.

At the present time the ore raised from No. 2 shaft is trammed on the surface by overhead rope gear to No. 1, where it is dumped into a surface box overlying the shaft. From this box it is raised in the skips to the sorting plant. Thus pending the completion of the arrangements just described the whole ore production of the mine is dealt with by the sorting plant described in the next section. This is illustrated in fig 1, which is a diagrammatic vertical section through the sorting house, with much of the constructional detail omitted, the main features only of the system being shown.

Fig. 2 shows the outside of the sorting house and of the inclined head gear of No. 1 shaft, which together form practically one structure.

SORTING WITH REVOLVING TABLE.

The ore is tipped by the skip on to a grizzly, A, with bars spaced 1½ in. apart, through which the fine stuff falls into a lower bin (not shown) and need not be further considered as it undergoes no sorting. The coarse lumps slide down to the shoot, B, and thence to the table, CC, the supply being regulated by a gate at the mouth, D, of the shoot. The gate is made in the shape of a comb with the teeth projecting downwards, this form having the advantage that it can be more readily lowered into the ore than one formed of solid plate. It is pivoted to a lever arm and counterbalanced so that it is easily worked by one kafir. As the ore slides down the grizzly bars it is sprinkled by water jets, regulated by a second kafir, and when it reaches the table it is thoroughly washed by a third kafir with a hose pipe jet of water. A fourth boy spreads the ore over the table with an iron bar while a fifth clears away any dirt which splashes off the table.

The table is of the annular type, and in this case there are four sorting boys inside the ring and about fourteen around its outer circumference. These boys pick out the lumps of waste rock from the mixed mass which passes slowly by, and throw them into an opening in the floor, which occupies a large part of the space enclosed by the table. Through this opening the waste rock falls into a large bin, E, and is discharged from the bin into trucks and run to the waste rock dump by the elevated track seen in the photo of the headgear.

The milling ore is carried round by the table, and is scraped off at a point on the outer circumference by a fixed bar set at an angle to the direction of the motion at that point. It falls on to the grizzly, F, which delivers the coarse stuff to a Gates crusher, G, through which it passes to the ore bin, H. The finer stuff goes down a pass, J, to a bin, K, whence it is fed into a Blake crusher, L, from which the broken ore falls into the storage bin, M. From the two bins, H and M, it is sent to the mill.

The sorting table is 25 ft. in diameter overall, while the ring is 4 ft. wide. It revolves at one half revolution per minute. The total area is 264 square feet and the rock passes the sorters at a mean velocity of 33 ft. per minute, thus affording an area of 132 square feet per minute. This is sufficient for sorting the whole of the coarse material included in an average supply of twenty-five tons of ore per hour.

MAIN POWER PLANT.

The following brief summary of the various items included in the main power station near the mill will serve to give a general idea of the size and class of machinery used on the large mines.

There are eighteen boilers of the return tube type, 4 ft. 6 in. in diameter and 16 ft. long, rated at 140 h.p. each. These are built in pairs side by side in one row, and a range of coal bunkers extends along the whole length of the boiler house, with a space 15 ft. wide

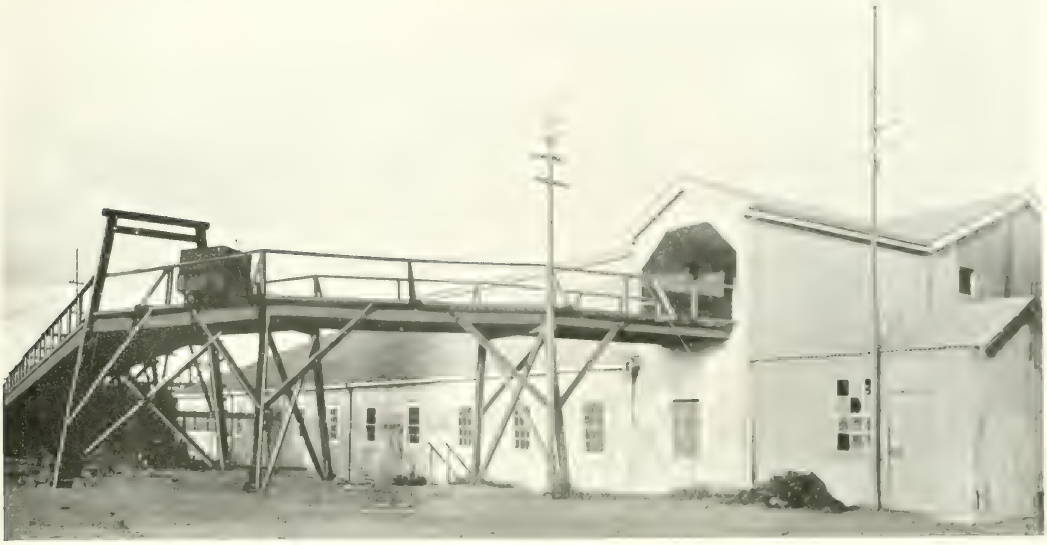


Photo by Author.]

FIG. 3. BACK OF MILL BUILDING, ILLUSTRATING THE METHOD OF HANDLING THE ORE.

for the stokers between the bunkers and fire doors. A railway siding passes along the back of the bunkers so that the coal can be delivered directly into the latter from the railway wagons at one handling.

There is a triple-expansion vertical King engine, which indicates up to 600 h.p., coupled direct to the battery line shaft. The cylinder dimensions are as follow :—

High-pressure	19 in.
Intermediate	30 in.
Two low-pressure, each ...	30 in.
Stroke	42 in.

This engine also operates, by a rope drive, the countershafting for an electric power transmission plant, consisting of six Mather and Platt generators, each of 100 h.p., giving 620 amperes at 120 volts. These work the mine pumps, and the main pumping plant at the dam, lifting 50,000 gallons of water per hour, and they also supply current for the electric light above and below.

There is an auxiliary Mill engine of the horizontal tandem composed type, with 28-in. and 48-in. cylinders and 48-in. stroke, developing 800 h.p. which drives the battery shaft by rope gearing.

COMPRESSOR PLANT.

This includes one double cross-compound King-Riedler compressor rated at 35 drills, which has the following dimensions :—

High-pressure cylinder ...	19 in.
Low-pressure cylinder ...	30 in.
Air cylinder, 1st stage ...	30 in.
Air cylinder, 2nd stage ...	18 in.
Stroke	42 in.

Also a horizontal side by side compound 25-drill Riedler compressor, with 18-in. and 28-in. steam cylinders, 28-in. and 18-in. air cylinders and 30-in. stroke.

The whole of the power plant, except the electric motors, has been supplied by Messrs. Fraser and Chalmers, who are also responsible for the Riedler compressors so largely used on these fields.

THE MILL.

The ore is brought from the lowest bins of the headgear to the mill in 20-cubic feet V-shaped side-tipping trucks, operated by an overhead endless rope gear of the usual type. The mill site is at a lower level than the shaft head and the haulage rope delivers the trucks at the mill door on the top platform, where the trucks are disconnected from the rope and run on to gentle down grade track over the top of the mill bins into which the ore is tipped at any desired point. The empty trucks then pass out at the other end of the mill and along the staging shown in the photograph (fig. 3), back to the return rope and so to the head gear. Owing to the favourable nature of the ground on this property, therefore, the cost of a mill hoist and the power for working the same is avoided.

The present mill includes 40 stamps of 1,000 lb., and 160 stamps at 1,250 lb., the former crushing about 4½ tons, and the latter 5 tons per stamp per day through 800 mesh screens. Blanton cams and Challenge feeders are used throughout. The plates are 10 ft. long by 5 ft. wide, and, having no intermediate drops or riffles, they present a uniform and unbroken surface to the flow of the pulp.

There are no splash plates or lip plates, but at the foot of the table there are two mercury traps, one below the other.

WATER REGULATION.

One apparently small but really important improvement introduced by the mill manager, Mr. H. L. Harland, is the provision of two cocks on the water supply pipe for each mortar box, one behind the other. One of these cocks is accurately and *permanently* adjusted to allow of the exact flow of water required, while the other is used for shutting off the water altogether when necessary, so that the first one is not interfered with. The advantage of this arrangement is that when the second cock is opened again after a stoppage, the proper quantity of water is immediately delivered without the loss of time for adjustment which occurs when only one cock is used.

AUTOMATIC MERCURY FEEDER.

The most novel feature, however, in the working of this mill is the use of an automatic apparatus invented by Mr. Harland for feeding the mercury into the mortar boxes, which was referred to a few months ago in the "Monthly Résumé." It is illustrated in figs. 4, 5, and 6. The essential part of this little machine is a disc, *a*, about six inches in diameter, which carries a number of iron cups, *bb*, on one face near the circumference. By means of a cone pulley, *c*, the disc is slowly rotated, and the lower part of it dips into a trough containing mercury, so that each cup as it rises from the trough carries up with it a small globule of the quicksilver. When a cup arrives near the top of the circle, the mercury is discharged on to a shoot, *d*, which delivers it through the pipe, *e*, to the mortar box. The motion of the disc is so slow that the whole globule is not delivered at once, but in a series of small drops at short intervals as the tilting of the cup increases. The breaking away of each separate drop is

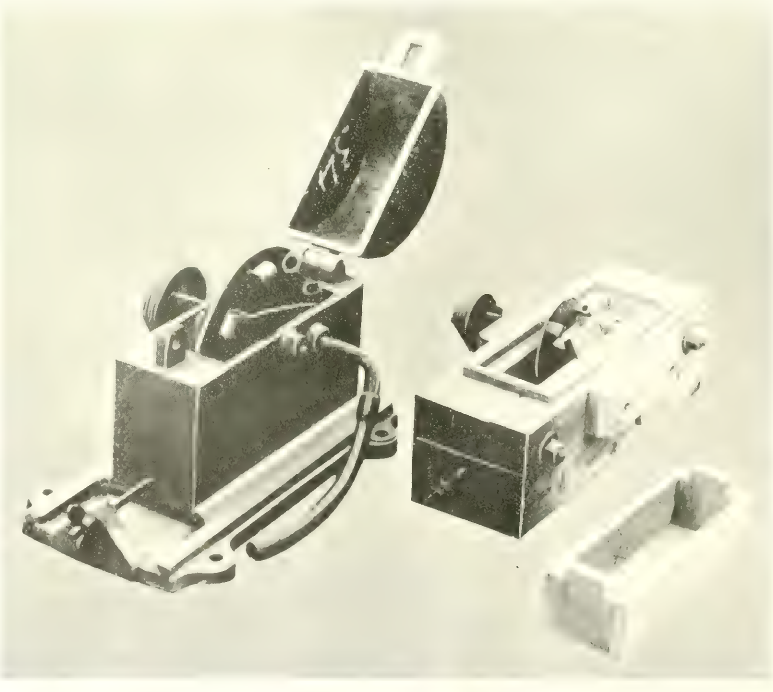
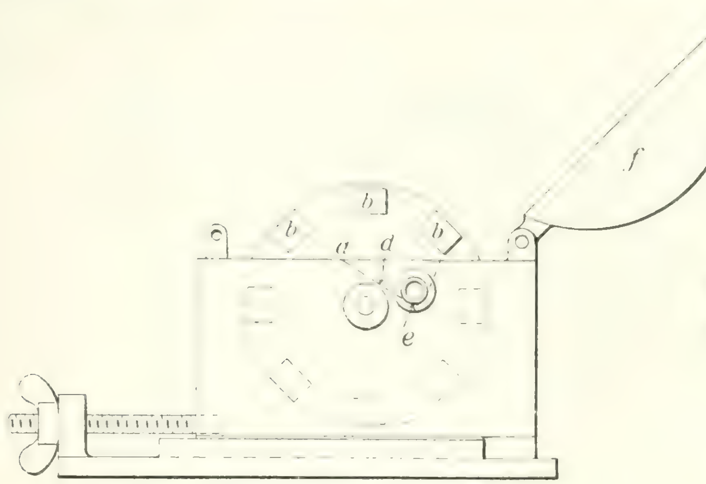


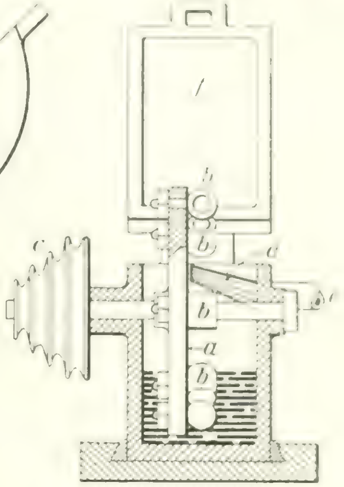
Photo by Author.

FIG. 4. HARLAND'S AUTOMATIC MERCURY FEEDER FOR STAMP MILLS.



Elevation.

FIG. 5.



Section.

FIG. 6.

assisted by the slight vibration of the battery framing on which the machines are mounted. Two forms of the machine are illustrated in the photograph (fig 4), the one on the right is an experimental type made with wooden trough, casing, and cover, while the one on the left hand side of the picture is the form shown in figs. 5 and 6. It is constructed of metal throughout, with a hinged lid, *f*, and is the actual form now being put on the market by Messrs. Fraser and Chalmers.

One such machine is used for each mortar-box, and they are all driven from a very light shaft (in this case the shaft is made of half-inch gas pipe), which runs the whole length of the mill, and is itself driven from the mill shafting through a series of small countershafts and pulleys, which reduce the speed to the extent required. A pair of reversed cone pulleys is included in this reducing gear, for the purpose of altering the mercury feed of the whole mill at once, when necesssary, but when the feed of any single machine requires adjustment, this is effected by shifting the driving cord on to a larger or smaller part of the cone pulley, *c*. The machine can slide in V-grooves in its base plate, like the slide rest of a lathe, and has a tension screw, *f*, with a butterfly nut to compensate for the different diameters of the grooves in the cone pulley, *c*, so that the adjustment can be made without altering the length of the cord.

AUTOMATIC *v.* HAND FEEDING FOR MERCURY.

This question can, of course, be discussed quite apart from the merits of any particular form of apparatus, which may be used for the purpose of feeding.

It seems to me almost self-evident, if the mercury is delivered into the box at intervals of half an hour in quantities of say an ounce at a time or more, that in a very short time, say ten minutes at the outside, all of it that has not splashed through the screen must have found its way to the bottom of the box, and consequently, that for the next twenty minutes there is practically none of it in contact with the rock that is being crushed. Whereas the addition of, say, one-twelfth of an ounce in several small globules at only, say, five minute intervals, must of necessity tend to a greater uniformity in this respect, and consequently lead to a larger percentage of gold being amalgamated *inside* the mortar box. The supply of mercury through the screen to the plates must also be more regular than with hand feeding, and the condition of the plates is therefore more uniform, and the chance of catching gold *inside* the box is also increased.

The figures in Tables I. and II., so far as they go, fully confirm this reasoning, for not only is there a *very marked increase* in the proportion of the gold which is caught inside the box, but there is also a distinct though comparatively

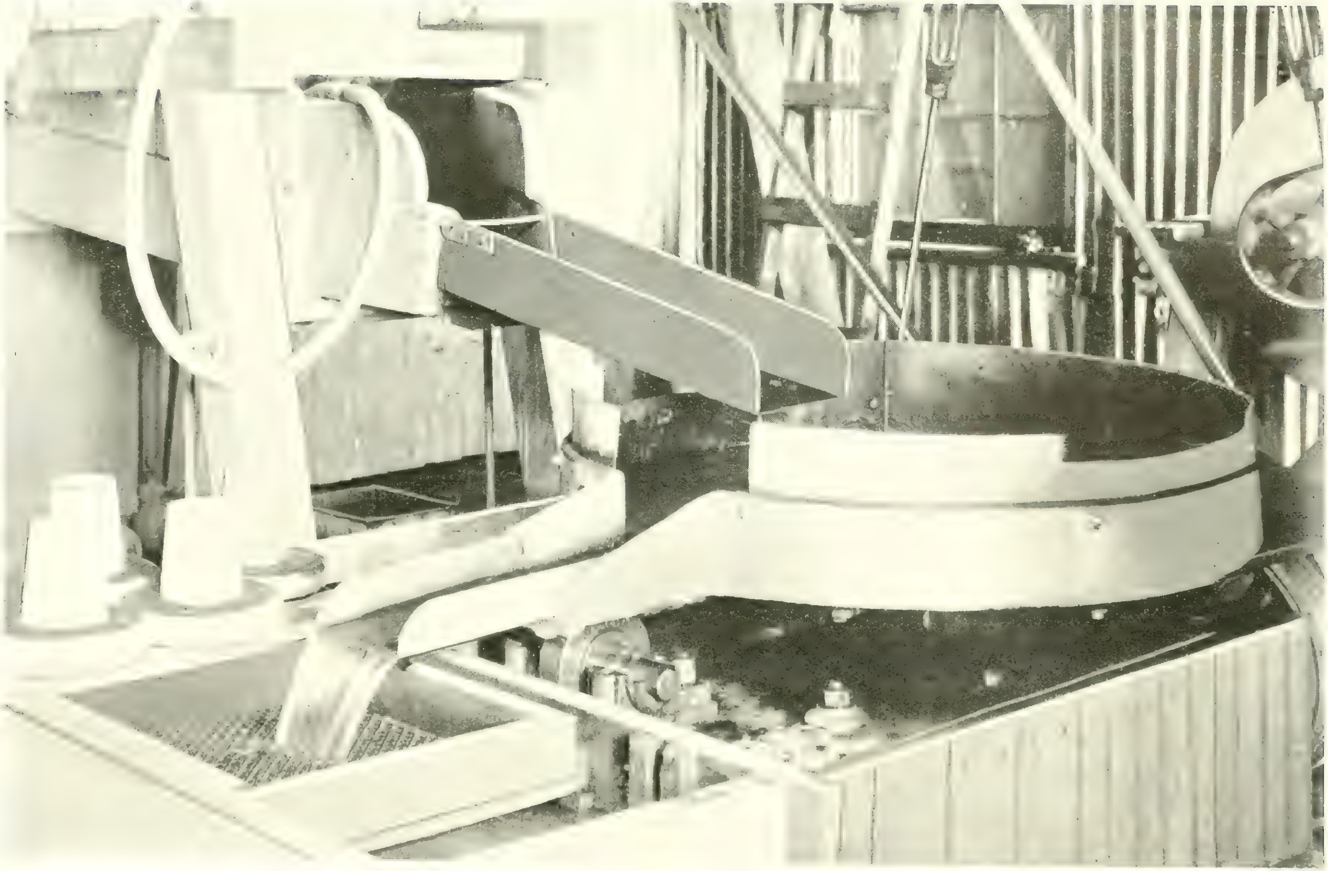


Photo by Author.]

FIG. 7. THE BATEA USED FOR CLEANING AMALGAM AT THE ROBINSON MINE, JOHANNESBURG.

TABLE I.

RESULTS OF FEEDING MERCURY BY HAND AND BY AUTOMATIC MACHINE.

	Original Assay Value of Ore.	A.—Hand Feed.			B.—Automatic Feed.			C.—Automatic Feed.		
		Assay of Pulp passing Screen.	Assay of Pulp from Plates.	Gold caught per Ton of Ore.	Assay of Pulp passing Screen.	Assay of Pulp from Plates.	Gold caught per Ton of Ore.	Assay of Pulp passing Screen.	Assay of Pulp from Plates.	Gold caught per Ton of Ore.
1	1 1 12	1 5 12	9 18	11 18	1 2 12	9 6	12 6	1 2 12	10 0	11 12
2	1 4 0	1 4 12	9 6	14 18	17 0	8 0	16 0	19 12	10 0	14 0
3	19 2	19 2	8 6	10 20	14 6	8 0	11 2	1 2 12	9 12	9 14
4	1 5 0	1 1 12	6 0	19 0	12 0	7 0	18 0	1 0 12	10 0	15 0
5	1 0 0	1 3 0	9 6	10 18	13 12	6 12	13 12	1 8 0	7 6	12 18
6	1 5 0	1 1 2	8 12	16 12	15 0	7 0	18 0	1 3 0	7 8	17 16
7	1 7 0	19 0	10 18	16 6	19 12	9 0	18 0	1 1 0	12 6	14 18
8	2 5 0	1 10 0	10 0	1 15 0	1 2 0	10 0	1 15 0	1 7 12	9 12	1 15 12
9	19 0	18 12	9 12	9 12	11 0	7 0	12 0	18 0	7 0	12 0
10	15 0	1 0 12	8 6	6 18	11 12	5 0	10 0	15 0	5 12	9 12
Totals..	12 0 14	11 11 16	4 9 12	7 11 2	7 18 0	3 16 18	8 3 20	10 14 12	4 8 8	7 12 6
Mean Values.	1 4 1.4	1 3 4	8 22.8	15 2.6	15 19.2	7 16.2	16 9.2	1 1 10.8	8 20	15 5.4

small increase in the total recovery by the mill. This gain, however, is not the chief advantage aimed at by Mr. Harland when he introduced automatic feeding. He considers that a far more important item is the saving of the amalgamator's time and attention, which are then available for other equally important duties which cannot be performed by machines.

Table I. gives the actual assay office returns for ten consecutive days, and, although there are a few self-evident discrepancies, as, for instance in those cases where the sample from the screen gives a higher result than the corresponding ore sample, yet these do not seriously affect the average result. Such differences must always be expected in work of this sort when carried out on a large scale, however carefully it may be performed, for, in addition to the probable irregularities in the sampling, there is also the fact that the ore value on any particular day is obtained by sampling the rock which is going into the bins at the top, while the screen sample on the same date is from the ore which is passing to the stamps from the bottom of the bins. By taking the mean of ten days' work, the errors arising from such causes are considerably reduced, and for very long periods are quite negligible.

In Table II., the average results from the lowest line in Table I. are worked out as percentages calculated on the original value of the ore.

TABLE II.

	Percentage caught in Hand-fed Batteries.	Percentage caught in Batteries fed with Mercury by Automatic Feed.		
	A	B	C	Average of B and C
Amalgamated in boxes	3.71	34.33	10.84	22.58
Caught on plates..	59.09	33.77	52.44	43.11
Total recovery from both ...	62.80	68.10	63.28	65.69

CLEANING THE AMALGAM.

The coarse grit obtained when changing screens, the sand from the mortar boxes at the monthly clean-up, and, in fact, everything included in the comprehensive American term "battery dirt," is washed in revolving barrels. There are two of these steel barrels, each 2 ft. in diameter and 3 ft. long, with steel balls inside. They are driven at about 25 revolutions per minute, and the dirt contained is churned up for twelve hours with mercury and water, after which the whole charge is run through a shoot to a battery. To discharge the contents of the barrel in small quantities at regular intervals, the following method is adopted. In the charging door of the barrel there is a small hole which remains plugged during the above operation. For discharging purposes this plug is removed, and the barrel again rotated, so that at each revolution a small portion of the mixed material falls through the hole into the shoot leading to the batea. As this latter apparatus is not so well known or appreciated as it deserves to be, the following description of its construction and action are given as well as a special photograph of it (fig. 7).

THE BATEA.

This consists of a cast iron pan, about 3 ft. 9 in. in diameter and 8 in. deep at its circumference. The bottom is dished to a depth of $2\frac{1}{2}$ in. at the centre, and an outflow trough is provided at one side of the rim, the bottom of this trough being level with the base of the pan. In the machine illustrated the depth of the sides has been made up to 8 in. by the use of sheet steel plates, the body of the pan, however, being of cast iron. The pan is supported, just under the shoot, by a roller on a horizontal spindle, as clearly seen in the photograph. At two other equidistant points round its circumference, it is carried by suspension rods. Between these two rods, at a point diametrically opposite the roller above-mentioned, a horizontal crank disc is placed close to the floor and underneath the pan. The crank pin engages with the pan, and imparts to it a shaking motion through a circle 5 in. in diameter, and the crank runs at 125 revolutions per minute. The suspension rods necessarily give a slight tilting motion to the pan at every half revolution of the crank pin, each side alternately being slightly raised. The object of the whole arrangement is to produce a motion similar to that obtained in ordinary panning by hand, but of a regular and continuous character, so that all the light dirt is gradually washed off through the trough by the stream of water which is continually supplied to the pan by means of a hose-pipe, until finally nothing but clean amalgam remains in the batea. Six $5\frac{1}{2}$-in. steel balls are normally used in the pan to assist the separation of the amalgam from the dirt, but when extra grinding action is required, it is obtained by placing in the pan several of the worn out shoes seen on the left hand side of the picture.

SQUEEZING.

When the amalgam is clean it is removed and squeezed in a screw press of the following construction: An iron cylinder, 7 in. diameter and 18 in. long inside, has a perforated bottom plate with $\frac{1}{4}$-in. holes, which is easily detachable. The perforated plate is covered inside with stout canvas, above which the liquid amalgam is placed. The cylinder has a piston which is slowly forced downwards by a screw, whereby the excess quicksilver in the squeezed mass is pressed through the canvas, and hard, dry amalgam remains in the cylinder. Then the perforated plate is removed, and the further descent of the piston forces out the amalgam in the shape of a small stilton cheese, whose weight is sometimes up to 1,000 oz., or even more. There is also a hydraulic press, 4 in. diameter, which is used in the same way. When large quantities of amalgam have to be dealt with, the advantages of this treatment as compared with the older method of squeezing through pieces of chamois leather, are sufficiently obvious. The amalgam is then treated in an ordinary retort, 2 ft. 6 in. long by 12 in. diameter, built into a brick furnace in the usual manner.

(*To be continued.*)

BRITISH LOCOMOTIVES FOR ABROAD.

BY

CHARLES ROUS-MARTEN.

Since the commencement of this series of articles, the author's optimistic view as to the prospects of British locomotive manufacture has been justified by several important contracts secured in competition with foreign builders. Mr. Rous-Marten completes his survey of British locomotives built for abroad, with some account of the products of Messrs. Kitson and Co., the Hunslet Engine Company, and other firms.—ED.

III.

HAVING passed in general review some of the doings both past and present of the three great locomotive building firms of Glasgow—now welded into one huge "combine"—I come next to the two leading builders who carry on their business in or near Leeds, viz., the Airedale Works of Messrs. Kitson and Co., and the Hunslet Engine Company.

Messrs. Kitson have long enjoyed a high reputation as builders of locomotive engines, both for home and for abroad. Their work always has won high praise for its substantial and excellent and perfect finish, while it has ever been recognised that the materials used would, as a matter of course, be of the best possible quality. They have supplied locomotives in very large numbers to many of our British railways, particularly to the Midland and Great Northern lines. The majority of these have usually been goods engines, but in some instances express passenger engines also have been built at the Airedale Works for English lines.

Two cases occur immediately to one's memory. In the year 1876, Messrs. Kitson built the first ten bogie express engines ever seen on Midland metals. These formed the second instalment of what may be termed Mr. S. W. Johnson's standard type, which had been preceded by those of Mr. Kirtley's build. It was in 1875 that Mr. Johnson began to bring out the first of his modern types, the batch of forty, with 6-ft. 6-in. coupled wheels; inside cylinders, 17½ in. by 26 in. The first thirty had only a single pair of leading wheels, and were constructed by Messrs. Dübs and Co. The second lot, ten in number, were fitted with leading four-wheel bogies, and were built by the firm now under notice, Messrs. Kitson and Co. It may be remarked here that except for variations in dimensions and minor details, these Kitson locomotives of 1876 are practically the same as

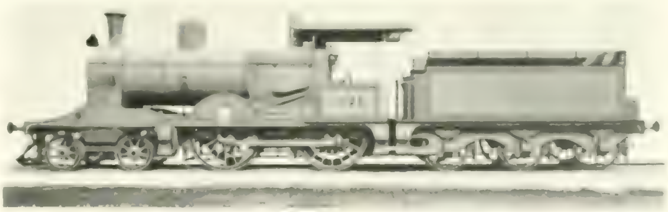


FIG. 9.—FOUR-COUPLED EXPRESS PASSENGER BOGIE ENGINE FOR THE [illegible] RAILWAY OF INDIA.

[illegible]

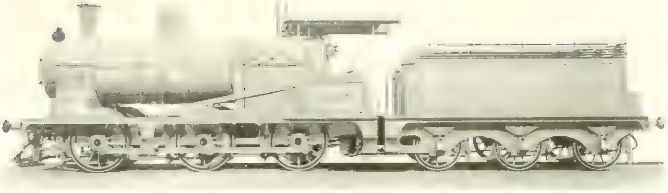


FIG. 2. SIX-WHEEL COUPLED GOODS ENGINE FOR THE SAME RAILWAY.

Cylinders: Diameter, 18½ in.; Stroke, 26 in. Total Heating Surface, 1,517 sq. ft. Grate Area, 27.5 sq. ft. Boiler Pressure, 160 lb. Water Capacity, 2,700 galls. Fuel Capacity, 7½ tons.

the most recently built type of Midland express locomotives, excluding the Belpaire and compound classes. The ten Kitson bogies were originally numbered 1310 to 1319, but subsequently 1312 to 1321, as they now remain. They have always been employed chiefly on the express work between Liverpool and Derby, and have been among the most useful and successful engines on the Midland road.

Another well-known British build of Messrs. Kitson was the "701" class on the Great Northern, designed by the late Mr. Patrick Stirling, which came out just twenty years ago. Their cylinders and coupled wheels were of the same size as those of the Midland "1312" class, but the Great Northern engines were without bogies. As in the case of the Midland engines, all are still at work.

During the past year Messrs. Kitson have built a number of locomotives for exportation abroad to various British dependencies and foreign lines. One of these (fig. 1) is a handsome four-coupled express passenger bogie engine for the 5-ft. 6-in. gauge, with 6-ft. coupled wheels and inside cylinders, 18½ in. by 26 in. It has 1285·3 square feet of heating surface in the tubes, and 116·5 square feet in the firebox—which is fitted with Mr. D. Drummond's patent water-tubes—total, 1,402 square feet. The boiler pressure is 160 lb. The engine weighs 45 tons 3 cwt. in working order, and has a 37-ton six-wheeled tender, having a water capacity of 2,700 gallons, and a bunker capacity of 7½ tons of coal. This locomotive has been built for the Madras Railway of India.

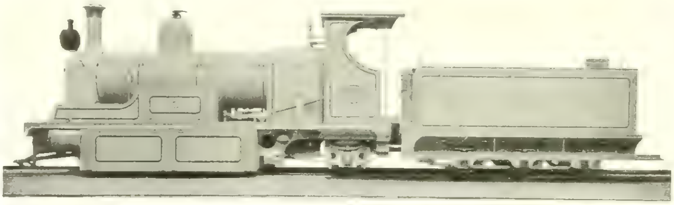


FIG. 4. AN EIGHT-WHEELER FOR BOMBAY, BARODA AND CENTRAL INDIAN RAILWAY.

Cylinders: Diameter, 11 in.; Stroke, 15 in. Total Heating Surface, [illegible] sq. ft. Grate Area, [illegible] sq. ft. Boiler Pressure, [illegible] lb. Water Capacity, [illegible] galls. Fuel Capacity, 2 tons.

Another engine type recently constructed by this firm for the same Indian railway is a six-wheel coupled goods engine of neat design, which has 4-ft. 6¾-in. coupled wheels, inside cylinders 18½ in. by 26 in.; 1,517 square feet total heating surface; 27½ square feet of grate area; and a steam pressure of 160 lb. The engine weighs 43 tons 6 cwt. in working order. The tender is identical with that belonging to the class of engine

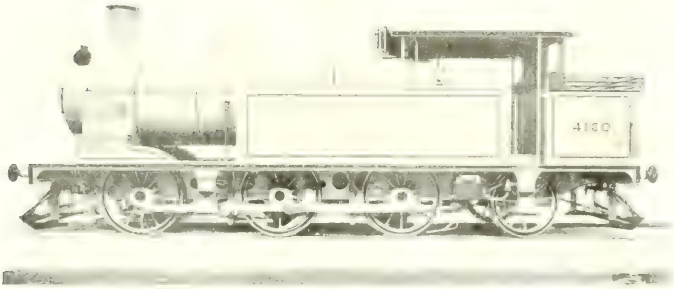


FIG. 3. A POWERFUL EIGHT-WHEELED TANK ENGINE FOR THE MADRAS RAILWAYS.

Cylinders: Diameter, 18 in.; Stroke, 26 in. Total Heating Surface, [illegible] sq. ft. Grate Area, 25 sq. ft. Boiler Pressure, 160 lb. Water Capacity, [illegible] galls. Fuel Capacity, 2 tons.

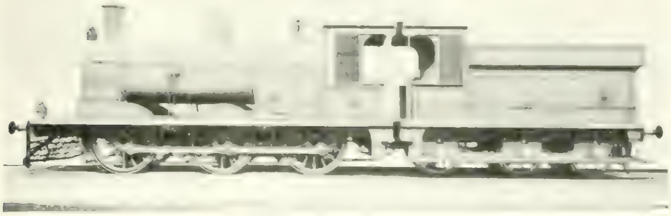


FIG. 5. POWERFUL TYPE OF GOODS ENGINE SUPPLIED TO THE BENGAL AND NAGPUR RAILWAY OF INDIA.

Cylinders: Diameter, 19 in.: Stroke, 26 in. Total Heating Surface, 1,216 sq. ft.: Grate Area, 24·75 sq. ft.: Boiler Pressure, 180 lb.: Water Capacity, 3,000 gals.: Fuel Capacity, 6 tons.

just previously noticed (fig. 2). A third class built for the Madras railways by Messrs. Kitson, is a powerful eight-wheeled tank engine, which has six-coupled wheels, 4 ft. 6¾ in. in diameter; and a trailing pair of carrying wheels with radial axle. The cylinders, as in the other two cases, are 18½ in. by 26 in., placed inside; the boiler affords 1,315 square feet of heating surface; the tank capacity is 1,500 gallons; total weight of engine loaded is 58 tons 8 cwt. (fig. 3).

For the Bombay, Baroda, and Central Indian Railway, which is constructed on the 2-ft. 6-in. gauge, Messrs. Kitson have built an eight-wheeled tender engine, which has six-coupled wheels, 3 ft. in diameter; and a trailing pair, 2 ft. The cylinders, placed outside, are 11 in. by 15 in.; the total heating surface is 550 square feet, and boiler pressure, 160 lb. The engine weighs 17 tons loaded, the tender, 11 tons 5 cwt. (fig. 4). The type, although small, will no doubt prove very useful for the particular duty it is designed to perform.

Fig. 5 shows a powerful type of goods engine which the Airedale Works have supplied to the Bengal and Nagpur Railway of India, which is of 5-ft. 6-in. gauge. It has six-coupled wheels, 5 ft. 1½ in. in diameter; inside cylinders, 19 in. by 26 in.; 1,216 square feet of total heating surface; 24·75 feet of grate area; 180 lb. steam pressure per square inch; it weighs 43 tons 16 cwt. loaded, and is accompanied by a six-wheel tender which carries 3,000 gallons of water and 6 tons of fuel, and weighs 36 tons 11 cwt. when full.

To the Selangor Government Railways (F.M.S.)—metre gauge—Messrs. Kitson have supplied a useful ten-wheel engine of the 4-6-0 class, which is shown in fig. 6. It has six-coupled wheels, 4 ft. 3½ in. in diameter; a leading four-wheel bogie, with [illegible] wheels; outside cylinders, 14½ in. by 20 in.; 1,730 square feet of heating surface, 150 lb. steam pressure. The engine weighs 29 tons 5 cwt. in working order, and has a six-wheel tender which weighs 21 tons 18 cwt. when fully loaded. A handy eight-wheel passenger engine has been turned out by the Airedale Works for the Government Railways of Ceylon, and is illustrated by fig. 7. It has four-coupled 5-ft. 1-in. wheels; four-wheel leading bogie; inside cylinders, 17 in. by 24 in.; [illegible] square feet of total heating surface, and [illegible] lb. steam pressure. The engine has

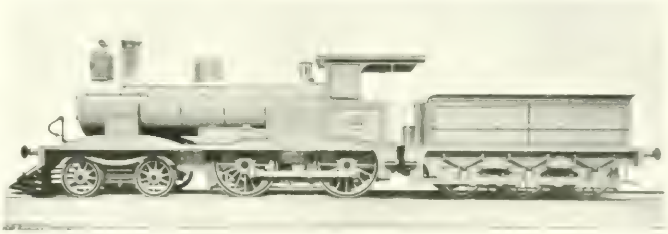


FIG. 7. HANDY EIGHT-WHEEL PASSENGER ENGINE FOR THE GOVERNMENT RAILWAY OF CEYLON.

Cylinders: Diameter, [illegible]: Stroke, [illegible]: Total Heating Surface, [illegible]: Grate Area, [illegible] sq. ft.: Boiler Pressure, [illegible]: Water Capacity, [illegible]: Fuel Capacity, [illegible] tons.

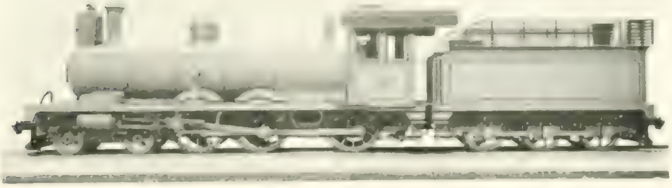


FIG. 6. USEFUL TEN-WHEEL ENGINE FOR THE SELANGOR GOVERNMENT RAILWAY.

Cylinders: Diameter, 14½ in.: Stroke, [illegible]: Total Heating Surface, [illegible]: Boiler Pressure, [illegible]

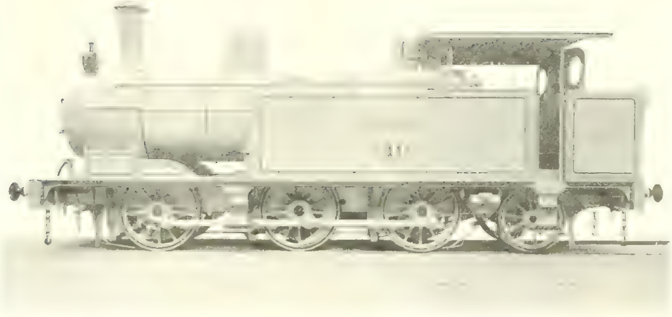


FIG. 8. A RADIAL TANK ENGINE FOR THE MAURITIUS RAILWAY.

Cylinders: Diameter, 18 in.; Stroke, 26 in. Total Heating Surface, 1,277·5 sq. ft. Grate Area, 22·25 sq. ft. Boiler Pressure, 165 lb. Water Capacity, 1,600 galls. Fuel Capacity [illegible]

a largely extended smoke-box, and weighs 39 tons 12 cwt. in working order. The gauge is the standard one of India, 5 ft. 6 in.

A radial tank engine of convenient type (fig. 8) has been built by the same firm for the Mauritius Railway. It has six-coupled 4-ft. 6-in. wheels; a radial carrying pair, 3 ft. 8 in.; inside cylinders, 18 in. by 26 in.; 1,277 square feet of total heating surface; 165 lb. steam pressure; and weighs 57 tons 5 cwt. loaded. The last engine on Messrs. Kitson's latest list is one of a somewhat peculiar type. It is constructed for the Anglo-Chilian Nitrate Railway Company, which is of 3-ft. 6-in. gauge. It is a double-ended sixteen-wheel tank engine, having eight-coupled wheels, 3 ft. 2½ in. in diameter, and leading and trailing four-wheel bogies. The connecting rod works on the third-from-the front coupled axle, and the first and third pairs of coupled wheels are flangeless. The cylinders, placed outside, are 17 in. by 21 in.: total heating surface is 970 square feet; and the steam pressure is 160 lb.; the total weight of the engine loaded is 51 tons 2 cwt. (fig. 9).

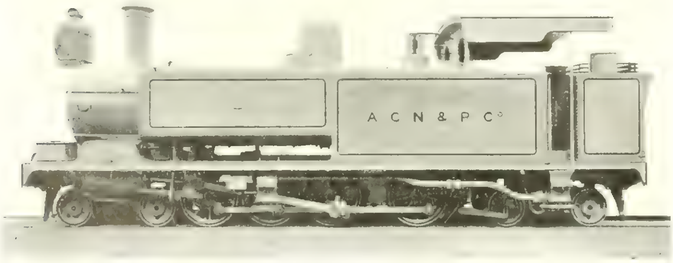


FIG. 9. A PECULIAR TYPE OF ENGINE FOR THE ANGLO-CHILIAN NITRATE RAILWAY COMPANY.

Cylinders: Diameter, 17 in.; Stroke, 21 in. Total Heating Surface, 970 sq. ft. Grate Area, 16 sq. ft. Boiler Pressure, 160 lb. Water Capacity, 2,070 galls. Fuel Capacity, 2 tons.

The Hunslet Engine Company, of Leeds, won for itself considerable celebrity in the Colony of New Zealand a good many years ago through four very excellent tank engines which they sent out for service on the earliest of the Government main lines of 3-ft. 6-in. gauge, constructed in what was then the province of Otago. Fig. 10 shows one of these engines. They all had 3-ft. 6-in. wheels six-coupled, and outside cylinders 13 in. by 20 in. They weighed 28 tons. Proving somewhat too heavy for the 40-lb. rails then in use, two of them were sent north from Dunedin to Christchurch, and

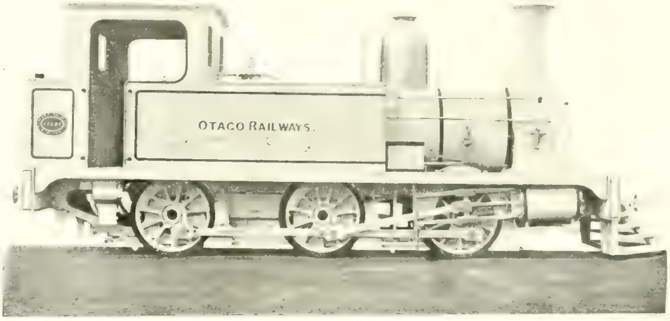


FIG. 10. TYPE OF ENGINE CONSTRUCTED FOR NEW ZEALAND BY THE HUNSLET ENGINE COMPANY.

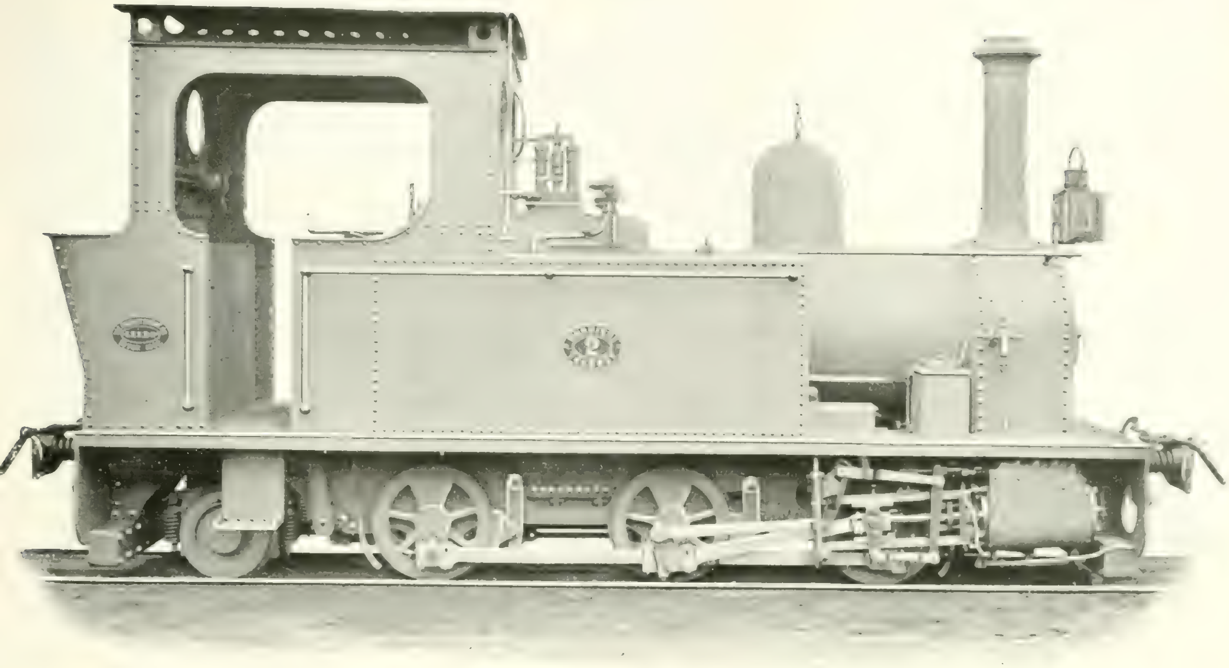


FIG. 11. TYPE OF NARROW GAUGE ENGINE BUILT BY THE HUNSLET COMPANY FOR EXPORT.

Cylinders: Diameter 9 in. Stroke 12 in. Total Heating Surface, 178 sq. ft. Boiler Pressure [illegible] [illegible] Fuel Space 27 cub. ft.

two to Invercargill, as 75-lb. and 72-lb. rails had been respectively laid in those districts where the original gauge was 5 ft. 3 in. on the one hand, and 4 ft. 8½ in. on the other. Subsequently all the Hunslet engines, which were romantically named after some of Byron's poems, *e.g.*, "Corsair," "Mazeppa," "Manfred," were rebuilt as ten-wheel four-coupled engines, having a four-wheel bogie at one end and a pony truck on the other, in which form they were long employed on the Napier-Woodville express duty.

They were in all respects most excellent locomotives of their class, and I have seen three of them come successively into the Christchurch goods yard hauling 70, 72, and 73 wagons of wheat. The Hunslet Engine Company's speciality is in tank engines and light tender engines, rather than heavy main line work. A large variety in sizes and types have been constructed by this firm, who have built engines for no fewer than thirty-five different gauges of railway. Extension of the workshops are now in progress to meet the increasing demands of their clients at home and abroad.

Recently the Hunslet Company have built a number of very well designed and constructed narrow gauge engines for export, among which I may mention one for the 2-ft. 6-in. gauge shown by fig. 11, which has six-coupled wheels only 2 ft. in diameter, and a two-wheel trailing bogie with 18-in. wheels, cylinders 9 in. by 12 in., and 178 square feet of heating surface, the total weight of the engine is only 13¼ tons loaded. This, although a very tiny machine as compared with some which I have just mentioned, possesses a number of advantages in respect of handiness and efficiency for working a pioneer railway in Northern Nigeria of such narrow gauge as 30 in. and rails 28 lb. per yard. Another type is a saddle tank for the 3-ft. 6-in. gauge shown

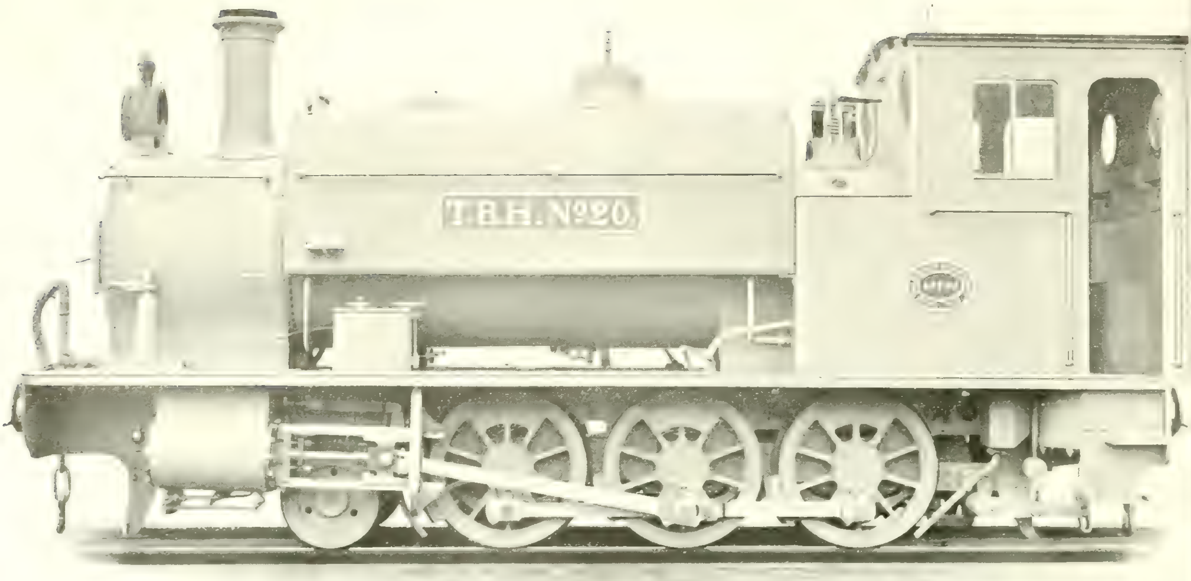


FIG. 12. ANOTHER TYPE OF SADDLE TANK ENGINE FOR THE 3-FT. 6-IN. GAUGE.

[illegible] Diameter [illegible] Heating Surface [illegible] Boiler Pressure [illegible] Capacity of Tank [illegible] galls. Fuel [illegible]

by fig. 12. It has 13-in. cylinders with a 20-in. stroke. 180 lb. working steam pressure, 39-in. driving-wheels six-coupled. and a pony truck with 2-ft. wheels. The rigid wheel base is only 7 ft. 2 in., and the pony truck is put close up to leading wheels and behind the cylinders. owing to the sharp curves on which these engines have to work at Table Bay Harbour and Docks. So successful have the first lot of engines proved. that the Harbour Board have ordered six more this year. A third. also a tank engine for the 3-ft. 6-in. gauge (see fig. 13), has cylinders 10½ in. by 16 in., six 2-ft. 9-in. wheels all coupled. and 362 square feet of heating surface. its weight loaded is 20 tons 4 cwt. It is specially built to withstand the rough and heavy work entailed in harbour construction. and fitted with grates for burning South African coal.

A six-wheeled side tank engine for a metre gauge railway in Spain has six 3-ft. 3-in. wheels all coupled. outside cylinders 13 in. by 18 in., 565 square feet of heating surface, and a loaded weight of 26 tons 11 cwt. very evenly distributed on the three axles. This engine is shown by photo (fig. 14).

Fig. 15 shows another class of engine built by the Hunslet Company, in this instance for the Ceylon Government Railways, 2-ft 6-in. gauge. They have outside cylinders 11½ in. diameter by 18-in. stroke, four coupled wheels, 3 ft. diameter. and a four-wheeled leading bogie 2 ft. diameter. rigid wheel base 6 ft. 4 in. The arrangement permits a boiler with large heating surface and firebox. The tank capacity of 820 gallons and fuel 98 cubic feet are also remarkable for the size of the engine. whose total working weight had to be kept within 23½ tons.

The actual weight in running order was 23 tons 7 cwt., of which 14 tons 17 cwt. are on the coupled wheels.

Another type is shown by fig. 16. It is of the "2.6.2" class, having six-coupled wheels, 3 ft. 0½ in. diameter, and a two-wheeled pony truck at each end, with wheels 2 ft.

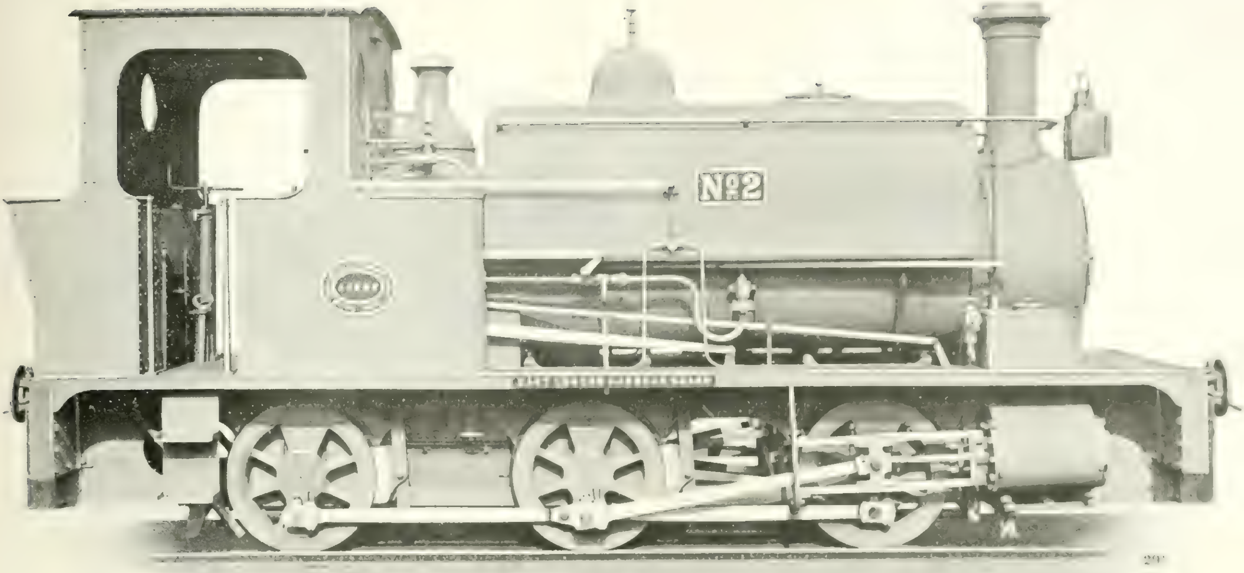


FIG. 13. A THIRD TYPE OF TANK ENGINE FOR THE 3-FT. 6-IN. GAUGE.
Cylinders: Diameter, 10½ in.; Stroke, 16 in. Total Heating Surface, 362 sq. ft. Boiler Pressure, 140 lb. C[illegible] [illegible] Tanks, [illegible] gallons. Fuel Space, [illegible] cub. ft.

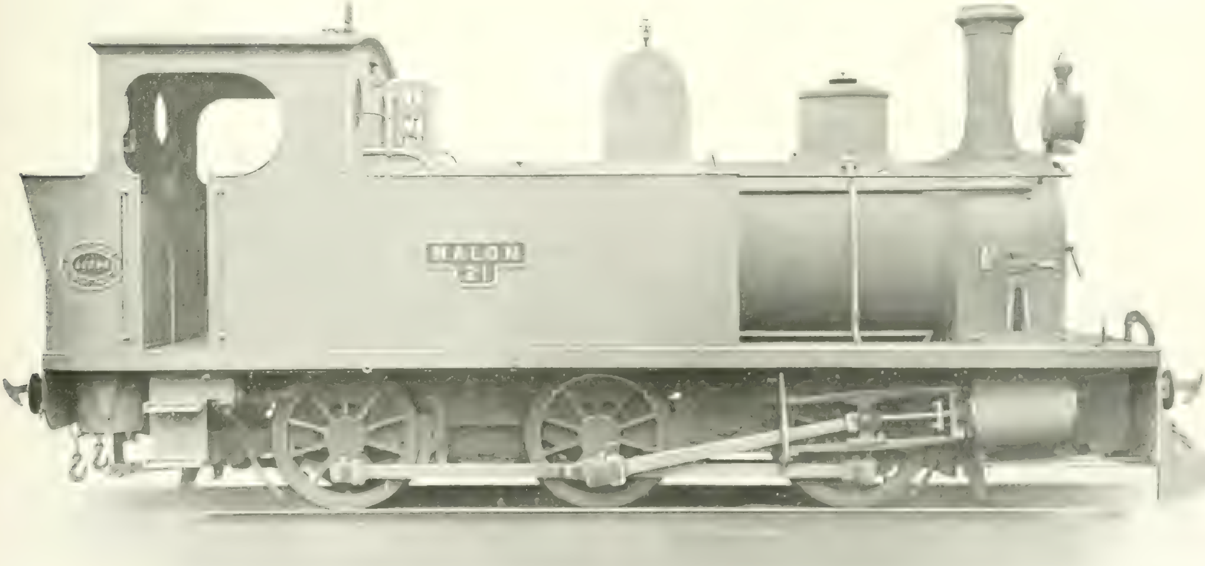


FIG. 14. [illegible]
[illegible]

diameter. It has been designed for working the branch line traffic of one of the large mining companies in South Africa. The bogie at each end enables it to negotiate curves equally well, either end first, and dispenses with the need for any turntable. The cylinders are 13½ in. by 18 in., working pressure 160 lb. Walschaert's valve gear is employed, so as to be accessible outside as the tanks extend whole length of boiler, and provide for 780 gallons of water and 34 cubic feet fuel. The boiler has 624 ft. of heating surface, with a grate area of 13·6 square feet, arranged for Colonial coal. The weight in full working order is 32¼ tons.

Manchester was in former days one of the principal centres of locomotive construction by virtue of claiming three of the leading building firms: Messrs. Sharp, Stewart and Co., Messrs. Beyer, Peacock and Co., and the Vulcan Foundry Company. Now, however, Messrs. Sharp, Stewart and Co. and its Atlas Works, have long migrated to Glasgow, and have been absorbed in the great North British "combine." Messrs. Beyer, Peacock and Co. still flourish at Gorton, two miles out, and so does the Vulcan Company at Newton-le-Willows, which, although I venture to describe it as a Manchester locality, is some miles farther away.

The Vulcan Foundry is among those firms of locomotive builders that have the longest historic connection with the British railways. Originally founded by Mr. Charles Tayleur, it built many of the earliest engines that run on English metals. So far back as October, 1834, it supplied a four-wheel goods engine for the Liverpool and Manchester Railway. In 1836 it built another four-wheel engine, but a single-wheeler, the other one being coupled, for the London and Greenwich Railway, and American locomotive history may be said to have practically begun with bogie engines sent out to the United States early in the "thirties" by Mr. Tayleur's firm, now the Vulcan Foundry. In 1838 the firm supplied an 8-ft. single-wheeler to the Great Western, the one known as Æolus, and numerous other historical locomotives were turned out by this company. In more modern times they have supplied many admirably built engines to the order of various leading British companies, designed by the respective locomotive superintendents of those railways, the Midland Company, in particular, procuring a number of goods and tank engines,

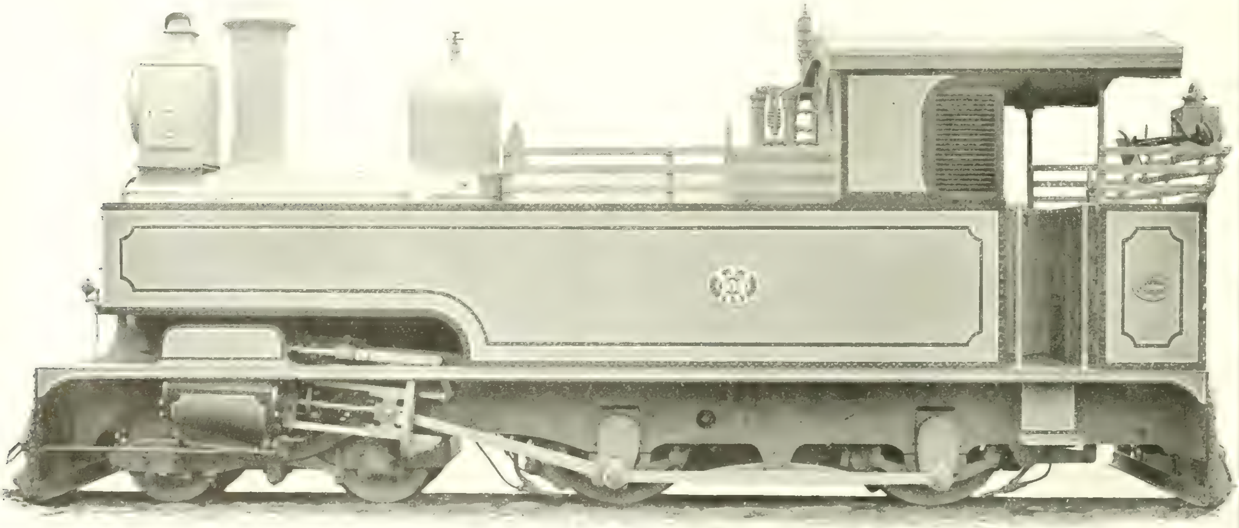


FIG. 15. ANOTHER CLASS OF ENGINE FOR THE CEYLON GOVERNMENT RAILWAY.

Cylinders: Diameter, [illegible] Stroke, 18 in. Total Heating Surface, 477 sq. ft. Working Pressure, 15[illegible] lb. Capacity of Tank, 825 gals. Fuel Space, 98 cub. ft.

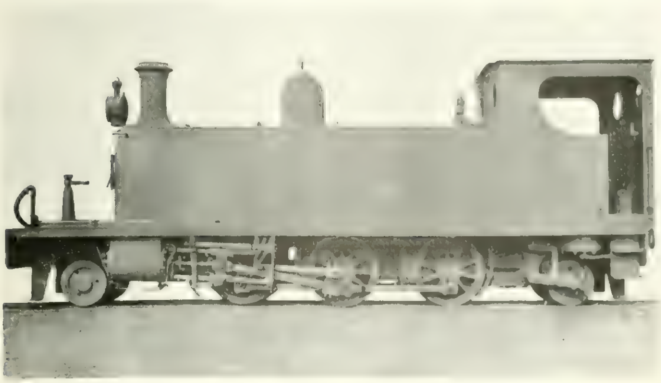


FIG. 16. A TYPE FOR MINING USE IN SOUTH AFRICA.

Cylinders: Diameter, 13½ in.; Stroke, 18 in. Capacity of Tanks, [illegible] gals. Total Heating Surface, 624 sq. ft. Working Pressure, 160 lb. Fuel Capacity, 34 cub. ft.

designed by Mr. S. W. Johnson, and, I believe, some express locomotives as well, from the Vulcan Foundry, some of the latest being a powerful class of goods tank engine running on six wheels all coupled, and bearing the Nos. 2456, etc. Several London, Chatham, and Dover express engines of Mr. W. Kirtley's design, *e.g.*, "192," etc., were built by this firm at Newton-le-Willows.

But the same builders have also turned out a large number of fine engines for abroad. To them was entrusted the construction of many built on the plan invented by the late Mr. Robert Fairlie, having a double boiler or two boilers back to back, working on a single frame, the groups of wheels being arranged on separate bogies having flexible steam-pipes. Locomotives of this type were sent out by the Vulcan Foundry to Norway, Portugal, Peru, United States, and New Zealand, and one of their latest exportations of this order was built for the railways of Burmah, a double six-wheel coupled engine of large power combined with great flexibility for working on curved railways of steep grades.

Another useful type produced at the same works is of a class not common in Britain, being virtually a "Mogul," with inside cylinders; that is to say, it has six-coupled wheels and leading two-wheel bogie. It has an extended smokebox and tender tank of somewhat unusual design.

I learn with much interest that since my notes were written about the three great locomotive building firms of Glasgow, which now form the North British Locomotive Company, that great "combine" has secured, after keen competition with leading American builders, several important contracts for abroad. One is with the Canadian Pacific Railway Company, for which line thirty-two large bogie express passenger engines are now in the course of construction, several having been already delivered (fig. 17), while twenty huge goods engines of the "Consolidation" or "2-8-0" type on the compound principle are about to be built for the same Canadian railway. Moreover, the North British Locomotive Company has undertaken a contract to supply a number of very powerful mountain-climbing locomotives to the Central Railway of Mexico. I am glad to be able to record these facts before closing my present series of articles.

At this stage I must stop for the present. It may be that the subject will call for further notice on some future occasion, but I think I have said enough to show that even if our British locomotive builders are meeting with active competition abroad, at any rate they are well holding their own, and are justifying the conviction which I expressed at the outset, that British locomotive building, so far from being effete, is still maintaining its position in the railway world.

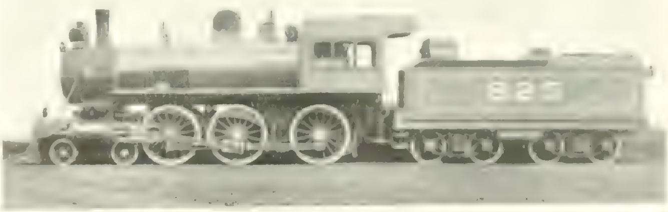


FIG. 17. ONE OF THE LARGE BOGIE EXPRESS PASSENGER ENGINES BUILT FOR THE CANADIAN PACIFIC RAILWAY.

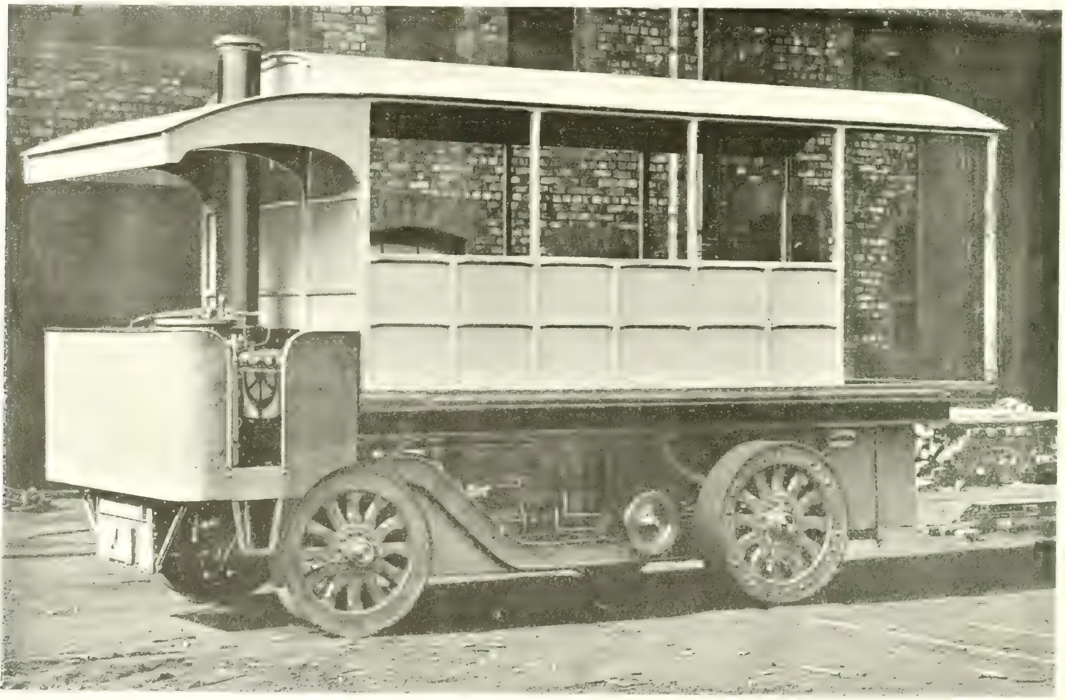
NOTES AND NEWS.

New Coke Fired Steam Motor Wagon.

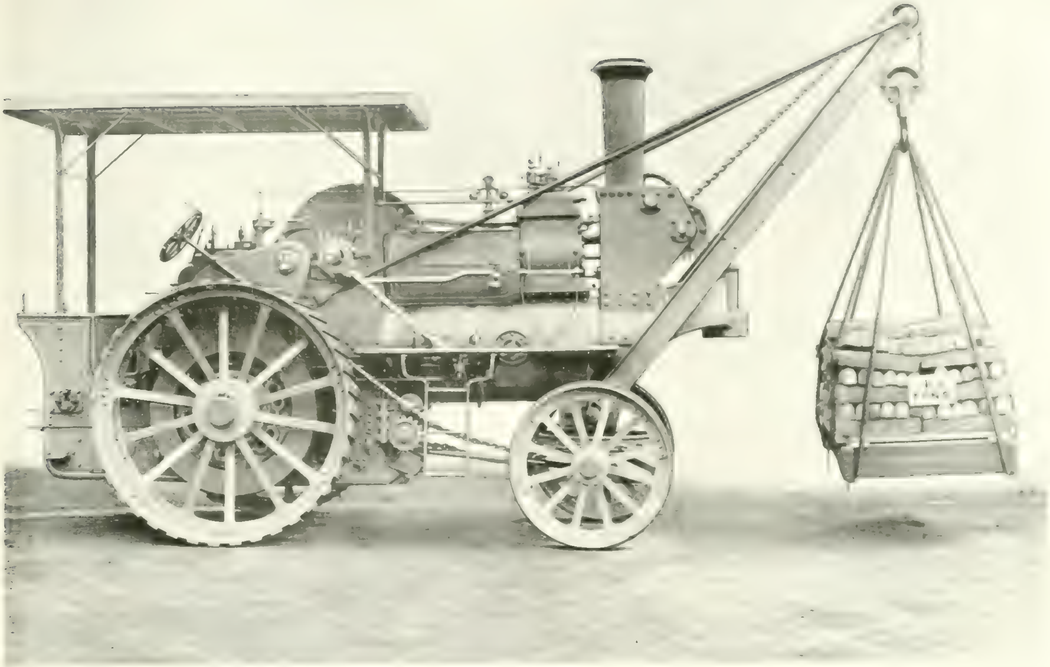
THIS vehicle was exhibited by Messrs. C. and H. Musker, Ltd., of Liverpool, at the Royal Agricultural Show. It is [illegible] ft. [illegible] in. long by [illegible] ft. [illegible] in. extreme width. The platform, which is made of hard wood with iron fittings, is 15 ft. [illegible] in. long, by [illegible] ft. [illegible] in. wide, and has 100 square feet of available surface for carrying goods. It is supported on springs and has no machinery fastened to it, so that it can spring, bend, or crosswind with load without affecting the machinery.

The arrangement of the boiler and machinery is on the "Musker" automatic system, that is, the supply of air to the fire, and water to the boiler, is wholly automatic, independent of the driver and in proportion to the amount of steam required, thus leaving the driver only to start, stop, or steer the vehicle. The heating surface is 7[illegible] square feet, the grate area 2½ square feet, and the test pressure 2,500 lb. per square inch. The fuel used is steam coal or coke. The working pressure is 250 lb. per square inch; two safety valves are fitted escaping into the water tank. The feed pump is driven from the engine shaft by spur gearing, and the amount of water delivered to the boiler is automatically determined by the steam pressure on the boiler, the driver not having to give it any attention.

The coke is supplied from a hopper on the front of the boiler, and the fierceness of the fire is automatically regulated by the temperature of the boiler by means of levers acting on the dampers. Practically no attention is required by the driver beyond keeping the boiler hopper filled with coke about once every two hours. The engine is horizontal, reversing, compound, with 4-in. and 7-in. diameter cylinders by 5-in. stroke, and is entirely enclosed in a dust-proof and oil-tight casing. It is made suitable for using superheated steam, and is fitted with an oil pump for forced lubrication.

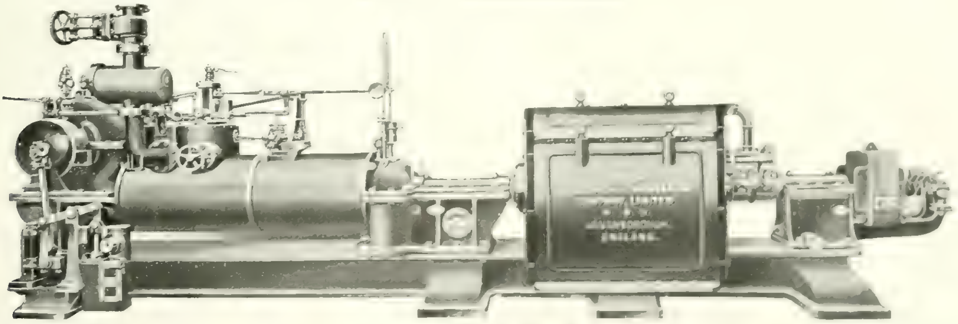


A NEW STEAM MOTOR WAGON.
Exhibited at the Royal Agricultural Show.



COMBINED ROAD ROLLER, TRACTION ENGINE, AND CRANE.

Built for H.M. Dockyard at Chatham, by Messrs. Clayton and Shuttleworth, Ltd.; this [illegible] convertible road-roller and traction engine combined with a crane, with capacity for lifting [illegible]. The illustration shows road-roller portion removed, and the crane lifting a test load of 4½ tons. It can be worked as a traction engine for hauling, a portable engine for driving machinery, [illegible] or a crane for lifting and transporting purposes.



THE BRUSH-PARSONS TURBO-ALTERNATOR.

The Brush Electrical Engineering Company, Ltd., has been investigating the advantages [illegible] the steam turbine, and as a result [illegible] with the Hon. Charles Parsons [illegible]. The Brush-Parsons turbine, now being constructed at Loughborough, embodies the experience of [illegible] years of its original designer and man[illegible]. The advantage in having [illegible] power weighing [illegible] tons is of course obvious.

Concurrently with the production of the turbine, the company is bringing out [illegible] new line of alternators and of [illegible] machines. We are informed that the alternators [illegible] parallel with special facility, ca[illegible] any power factor is only thre[illegible]. [illegible] single, for two, or for three-phase [illegible]. Beyond this pressure rotating [illegible]. The Brush Company [illegible] with boilers, super-heaters, and [illegible]

Colliery Exhibition at the Agricultural Hall.

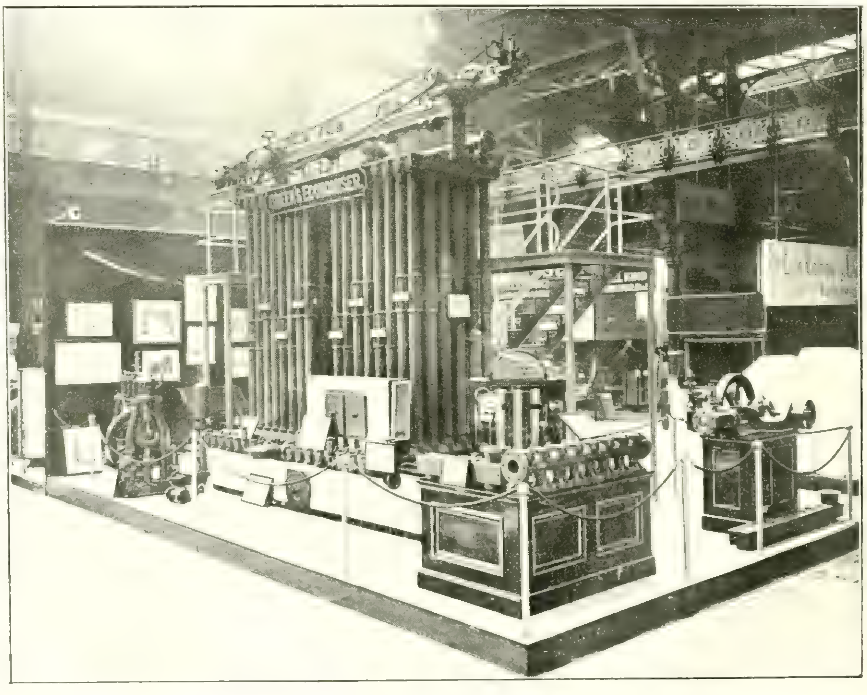
An attempt to bring together the manufacturer of plant and the colliery proprietor, this exhibition synchronised with the meetings of the Mining Engineers, and showed the existence of a very healthy enterprise among the producers of mining plant. On the occasion of our visit the attendance was a negligible quantity, but there is every reason to believe that a fair proportion of the visitors meant business. A limited number of inquiries, provided they are the right sort, are naturally more valuable to manufacturers of plant than the purely sight-seeing element; Mr. H. Greville Montgomery may be congratulated on having brought together a unique exhibition, small perhaps, but contributed to by thoroughly representative firms. Space does not permit a detailed notice of the exhibits, but we take the opportunity of calling attention to a few which were specially interesting.

One of the most prominent features of the Exhibition was Green's improved patent fuel economiser, and we gathered that its erection had occupied several days and nights. A section of the surrounding brickwork was shown, the tubes, with their ascending and descending scrapers being fully exposed to view. Those who wished to inspect the patent gearing for reversing the scrapers were able to do so by mounting a ladder at the side of the economiser. This method of heating the feed water for steam boilers by means of the heat in flue gases, aims at a reduction in the coal bill, varying from 15 to 25 per cent; it also makes for an increased steaming capacity of the boilers and there is large reserve of feed water at a high temperature always available for emergencies, or when the boilers are suddenly called upon for extra power.

At the well-arranged stand of the Pulsometer Engineering Company, Ltd., visitors had an opportunity of familiarising themselves with the working of the pulsometer steam pump. Other exhibits included the "Deane" Steam Pump and a "Deane" vertical sinking pump of the latest pattern; also various centrifugal pumps. The company also showed a working model of their Air Lift Pump, with air compressor driven either by steam, belt, or direct coupling, and an air receiver, in which the compressed air is stored. A special feature of this pump is the foot-piece, by the use of which a very considerable economy is effected in the quantity of compressed air used.

At the stand of Messrs. Hadfield's Steel Foundry Company, Ltd.—the largest in the building—Messrs. MacBean and Eaton's patent tub controller and Messrs. Hadfield's tub greaser were shown in practical application. The other exhibits included one of Messrs. Hadfield and Jack's stone breakers, a coke crushing mill, and a large variety of wheels and axles, rollers, pulleys, sections, and permanent way accessories.

Another imposing exhibit was that of Messrs. Ed. Bennis and Co., Ltd., of Bolton, comprising a "Bennis" stoker and compressed air furnace fitted to a large water-tube boiler—a similar machine as applied to a Cornish boiler; and a "Bennis" stoker and camel furnace, as applied to a Lancashire boiler, this machinery being driven by a "Westminster" engine—another speciality of the firm. An excellent idea was afforded of the efficiency and adaptability of the stoker. Messrs. Bennis have added to their plant a system of conveying the coal from any heap or bunker and distributing it to the machines fitted to the boilers, so that the men never touch the coal from the time it is thrown down into the yard or other store, the whole of the work being done by the conveying plant, and the machine firing apparatus, quite automatically.



GREEN'S ECONOMISER.
A prominent feature at the Colliery Exhibition.

The exhibition of Messrs. J. Halden and Co., Manchester, served to illustrate some of the most modern drawing office appliances, prominence being given to their Duplex Radial Electric Photo-Copying Machine. By an improved arrangement the frame employed in this apparatus can now be turned on pivots, as shown in photograph, so that it is unnecessary for the operator to stoop when using the copier. A tracing was copied for our special edification, and we were impressed by the celerity with which the attendant placed the tracing in the copier, manipulated the electric lamp, fixed the print, and drew from the patent squeegee a copy of the original, perfect in all respects. A number of other important accessories for the drawing office were also shown.

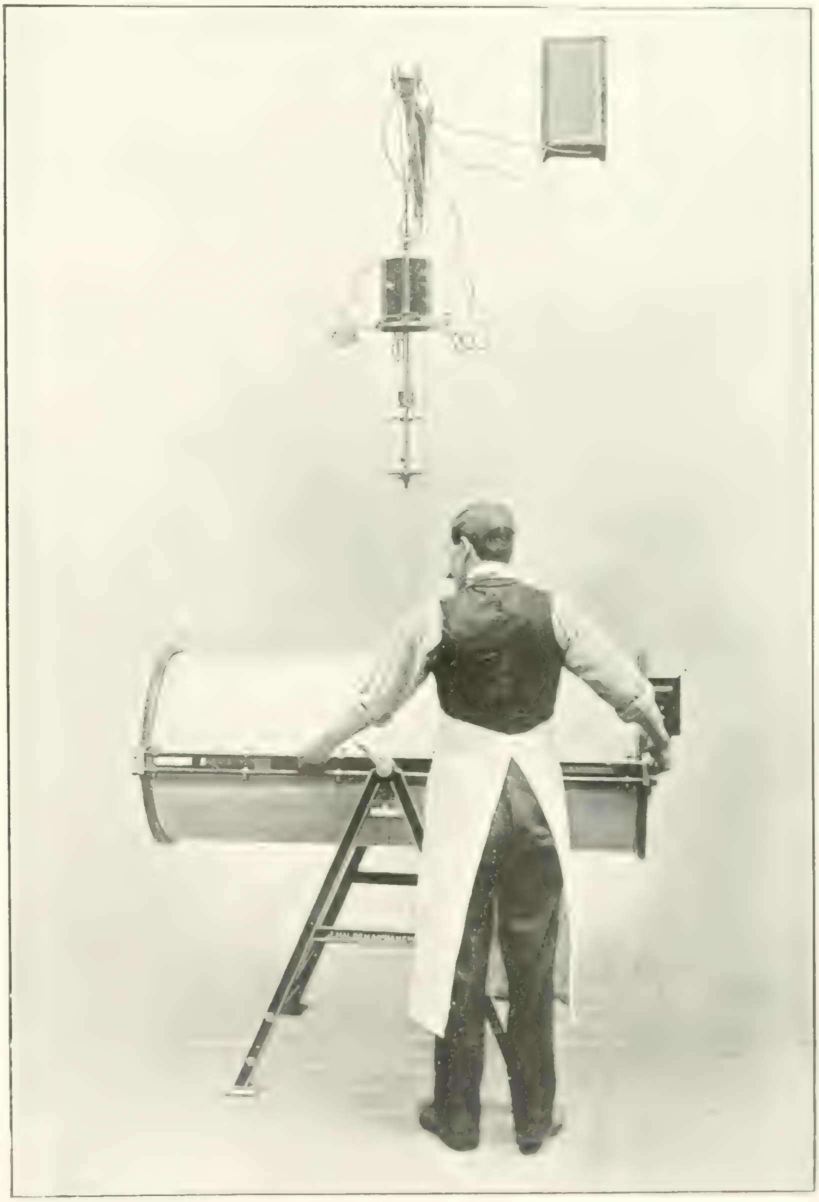
A comprehensive exhibit of mining tools and machinery, etc., was shown by the Hardy Patent Pick Company, Ltd., at whose stand were to be inspected various hand boring machines capable of boring materials ranging from the softest coal to the hardest materials it is possible to penetrate with the rotary drill. Other features of this exhibit included the "Daw" power rock drill—one of the latest types of percussive power rock drills, the "Elliott" coal washer, and the "Devil" and "Multiple" grinders.

Messrs. Meldrum Bros., Ltd., had a very interesting exhibition of their improved "low grate" forced draught furnace, specially designed for burning every class of colliery waste fuel for steam raising purposes.

Messrs. W. and T. Avery, Ltd., exhibited various patterns of their colliery or pitbank machines, including their patent pitbank weighing machine with self-indicating and printing beam; also platform weighing machines suitable for colliery purposes.

Messrs. Tangves, Ltd., who had one of the finest exhibits in the hall, showed a collection of pumps useful for mining purposes, and a Tangye's vertical steam engine, with 8-in. cylinder and [illegible], fitted with crank-shaft roller. The exhibit [illegible] a new vertical sinking pump specially constructed for use in water logged [illegible]

Messrs. Babcock and Wilcox, Ltd., exhibited interesting models of their patent water-tube steam boiler fitted with steam super-heater; their [illegible]



ELECTRIC PHOTO-COPYING INSTALLATION [illegible]

Position showing [illegible]

A NEW DEPARTURE IN CROSS CHANNEL SERVICE—THE TURBINE STEAMER "QUEEN."

chain-grate stoker and water softener and heater, together with specimens of steel steam piping, and a turbine tube cleaner.

The possibilities of the card system for use in connection with the working of mines and collieries are now well known, but it would be rash to assert that the system has reached its final stage of development, and we inspected the exhibits of the Library Supply Company and the Lyle Company, on the *qui* [illegible] for improvements. Among the most interesting features of the Library Supply Company's cabinets as distinct from those of other makers of card index accessories may be mentioned—their automatic gravity catches. These are used in connection with the tray cabinets, and, in our view, are an important accessory, as no tray can be removed from the cabinet of which it forms a part, without a slight pressure on this gravity catch or stop. The possibility of an upset in the absence of rods is thereby reduced to a minimum. The principle of the gravity catch is also applied to the rods, which automatically slide into place, and cannot be removed without pressure on the catch concealed under the tray.

The company also exhibited their patent sideless tray cabinets. These trays have no sides or back, but are provided with guideways for the cards. The invention is novel and ingenious, enabling the cards to be handled with greater freedom, and at the same time reducing cost of production.

We notice that the Lyle Company are now building their letter filing cabinets in sections, so that when additions have to be made to the letter filing outfit, they can be effected in a symmetrical manner. Both companies exhibited an interesting collection of office appliances.

Among the typewriters exhibited was the Oliver, frequent demonstrations being given as to its suitability for engineering work, more particularly in connection with the drawing of horizontal and vertical lines.

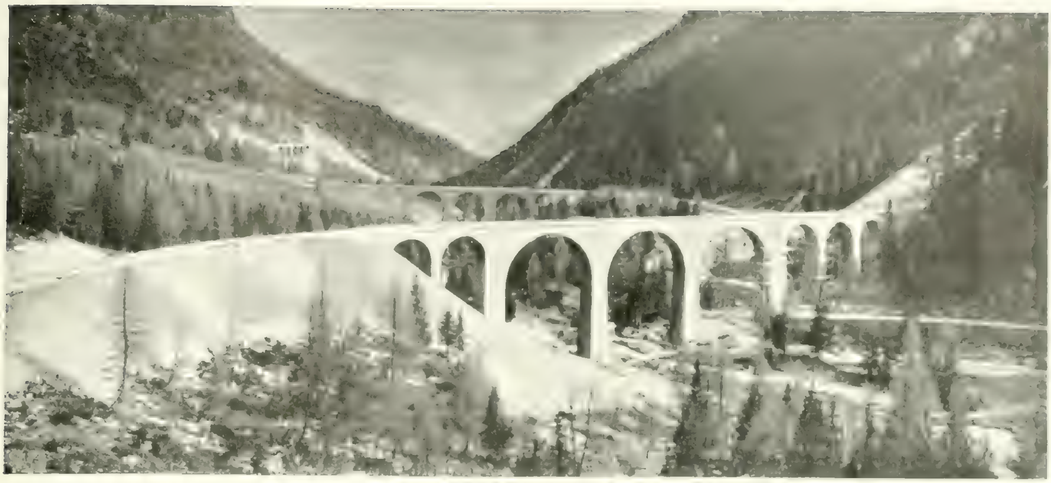
The New Turbine Steamer "Queen."

The application of turbine machinery to the new steamer *Queen* marks an important departure in cross-Channel service, and the South-Eastern and Chatham Railway Company are to be congratulated upon their enterprise. On the occasion of the inaugural trip, the new vessel made the passage between Calais and Dover in practically an hour—a performance which she will probably improve upon with a favourable tide.

The vessel, which was built by Messrs. William Denny and Bros., of Dumbarton, is 310 ft. long, with a moulded breadth of 40 ft., and a depth of 25 ft. She has three turbines with three separate lines of shafting, each carrying a single screw propeller. These were fitted by Parsons the Marine Steam Turbine Co., Ltd.

In ordinary running, the steam, at a pressure of 150 lb. to the square inch, first enters the central turbine of the three, and, after partially expanding, passes to the condensers through the two side (low-pressure) turbines, which are connected in parallel, the expansion being altogether about 125 fold. The shafts of these side turbines revolve rather more rapidly than the central one.

In manœuvring or coming alongside a quay the central turbine revolves idly in a vacuum, and use is made only of the side turbines, within the casings of which are placed two astern, or reversing, turbines, which by an appropriate arrangement of the controlling valves allow of the vessel being propelled astern at a speed of about 13 knots. They also enable her to be stopped with ease. Trials carried out on the Clyde showed that when going over 19 knots she could be brought to a standstill in 67 seconds from the time the telegraph order was rung from the bridge to the engine-room, the distance travelled in this time being equal to about two and a half times her own lenght. On the measured mile the *Queen* has attained a mean speed of [illegible] knots. For the accompanying illustration we are indebted to the South-Eastern and Chatham Railway Company.



DEVELOPMENT OF THE RAILWAY ABOVE BERGÜN.

THE ALBULA-ENGADIN RAILWAY.

BY

EMILE RUKER.

In all the cantons of Switzerland there is now a tendency to carry railways into remote valleys and elevated regions, which have been hitherto unattainable for railroads. The Albula-Engadin line, which was thrown open for traffic on July 1st, with much ceremony, is a remarkable example of the triumph of engineering skill over natural obstacles. The author gives a description of the line and emphasises its importance in connection with the development of international traffic.—ED.

DURING the last few years Switzerland has seen a marked development in railway enterprise. In 1898 more than 100 kilometres of standard and narrow-gauge railways were under construction, in addition to cog-wheel, tram and rope-railways. In Wallis the cog-wheel railway ascending the giant Gornergrat was being finished, the construction of the three great Alpine railways—the Jungfrau, Simplon, and Albula-Engadin lines had already been commenced, and the preliminaries connected with several other canton railways such as the Riken, Toggenburg, Wattwil-Uznach and Ilanz railways had been undertaken.

Although the Orient railway, which after the ingenious plan of the famous Guyer-Zeller was to be constructed with normal (standard) gauge running in an easterly direction through Graubünden (Grison), connecting up the neighbouring Tyrol lines and opening up international traffic has not been carried out, the name Guyer-Zeller will remain famous for ever as the constructor and promoter of the Jungfrau railway. Since the death of the Swiss railway king the construction of the latter is proceeding somewhat more slowly, but steady progress is nevertheless being made.

PRELIMINARIES.

Amongst the preliminaries of the now completed Albula-Engadin railway may be mentioned the establishment of the Prättigau railway leading from Landquart to Davos and continued *via* Chur to Thusis, which was opened for traffic in the years 1890, 1896. By the adoption of the narrow gauge system for these railways a decisive step was taken in the direction of a Cantonal Rhætian railway system—a vital question for the Canton Graubünden (Grison), inasmuch that it has hitherto been almost destitute of the benefits

VIEW OF THE RAILWAY—SCHYN RAVINE.

of railway traffic. Such a system could, of course, only be satisfactorily arranged by accepting the metre gauge.

ESTIMATED COST OF CONSTRUCTION.

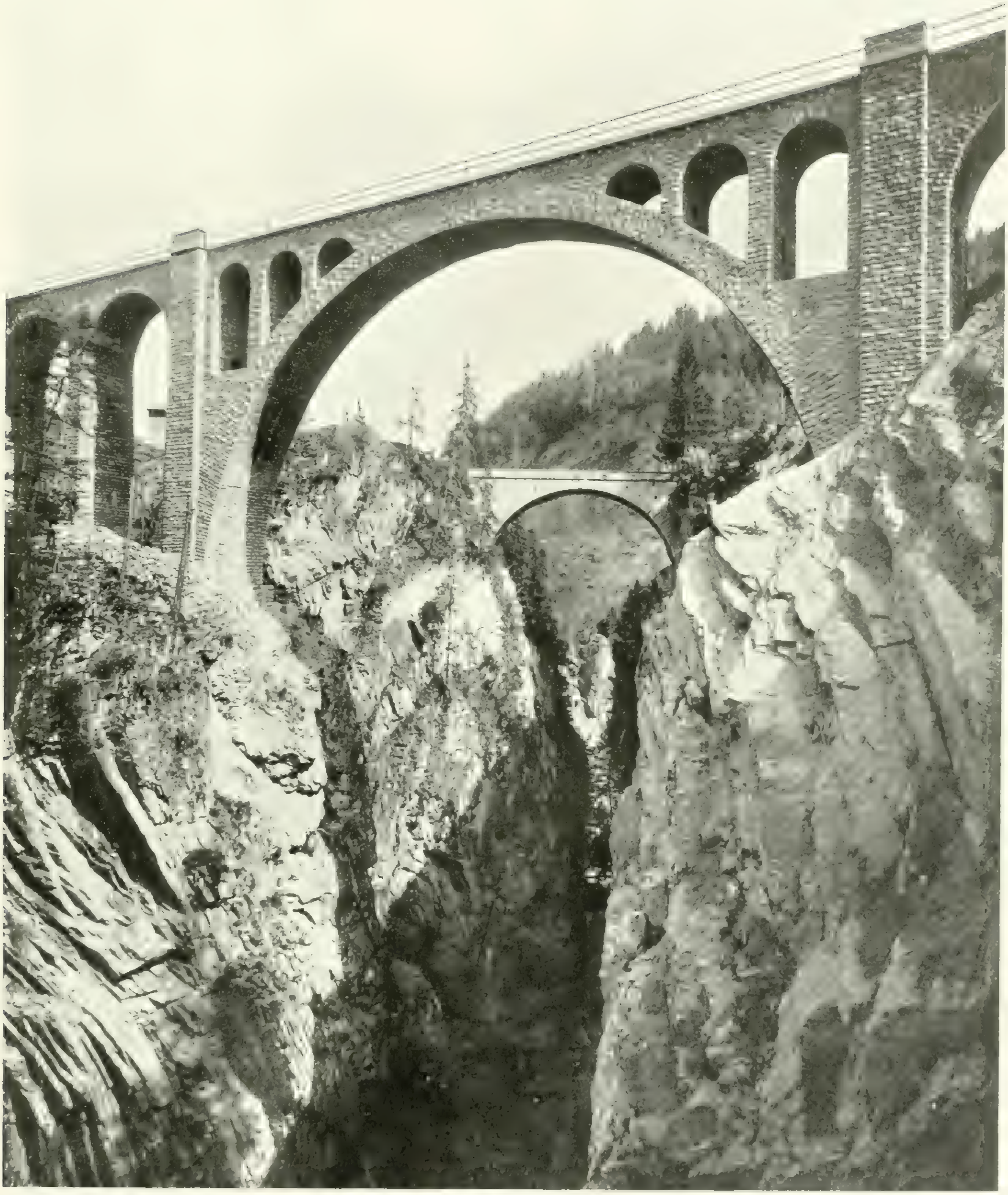
The Cantonal Government having charged itself with the construction of the railway system through the chain of valleys and their connections, by the Bill of June 20th, 1897, began with the construction of Albula-Engadin railway leading from the Rhine valley into the Engadin. The scheme of the chief engineer, Fritz Hennings, of the Rhaetian railway, was accepted by the Central Government of Switzerland, which placed itself at the head of the enterprise by taking subscription shares to the amount of eight million francs. The total estimate amounted to twenty-two million francs. Financial assistance has also been freely given by the cantonal and local administrations, whose mutual interests are concerned.

It is perhaps somewhat curious that the Engadin has been opened to railway traffic from the north-west by constructing enormous works, bridges and tunnels, instead of by the more natural routes from the Austrian frontier, *via* Landeck and Finstermünz, in connection with the Vintschgau railway from Meran, or from the Italian frontier by the Maloja Pass. The choice of route may be explained by the fact that the designs provide for the later construction of an Engadin line for the Upper Engadin to the much frequented bath Schuls-Tarasp-Vulpera, situated in the Lower Engadin and 15 kilometres from the Austrian frontier, both these lines being of standard gauge.

The railway which extends from Thusis in the Rhine valley to St. Moritz in the Engadin, traverses beautiful scenery, and will open up the south of Chur, bringing the Albula and Bernina regions, famous on account of their thermal baths, within the compass of a single journey.

DIFFICULTIES OF CONSTRUCTION.

Difficulties of construction, owing to the varying character of the ground (slate, dolomite, gravel, granite, limestone, etc.), and to large water springs encountered in the tunnels, were increased by the special precaution for men and materials necessary in these Alpine regions. As it was the intention of the engineers to complete the railway as soon as possible, negotiations were first entered into with the proprietors of stone pits, magazines, and stores *en route*, in order to begin the construction simultaneously at different places.



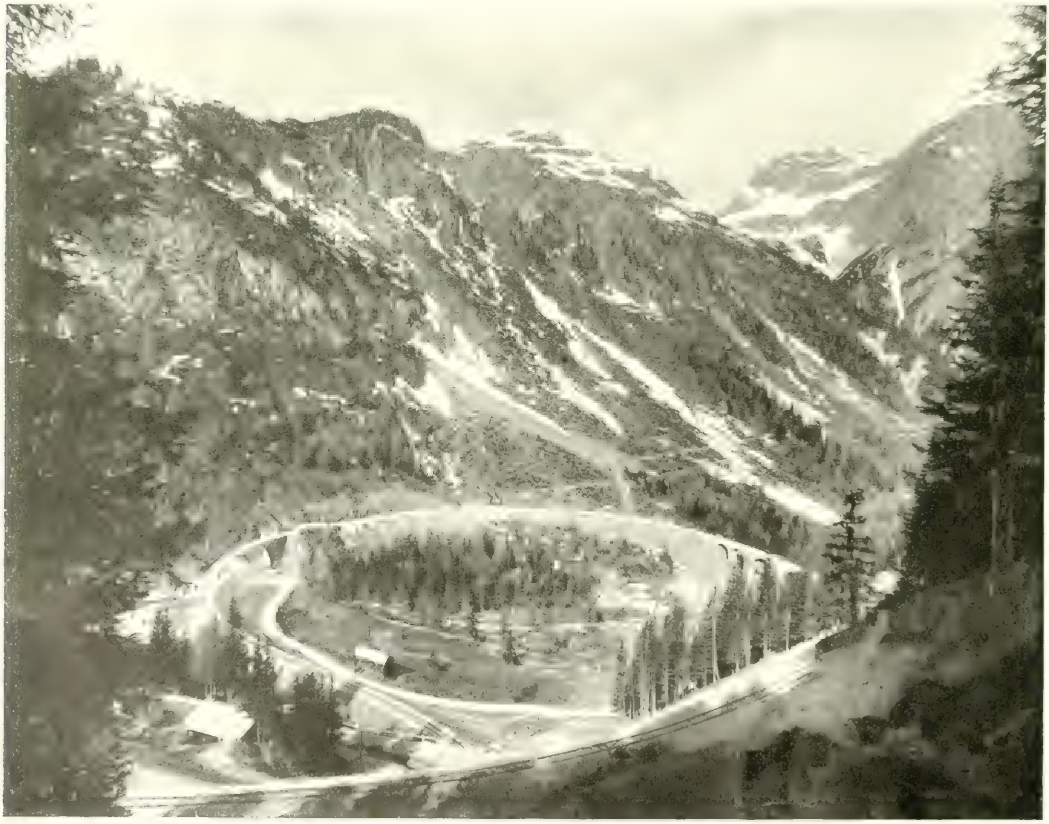
SOLIS BRIDGE OVER THE SCHYN RAVINE.

The following comparison of summit tunnels on this and other European railways is interesting :—

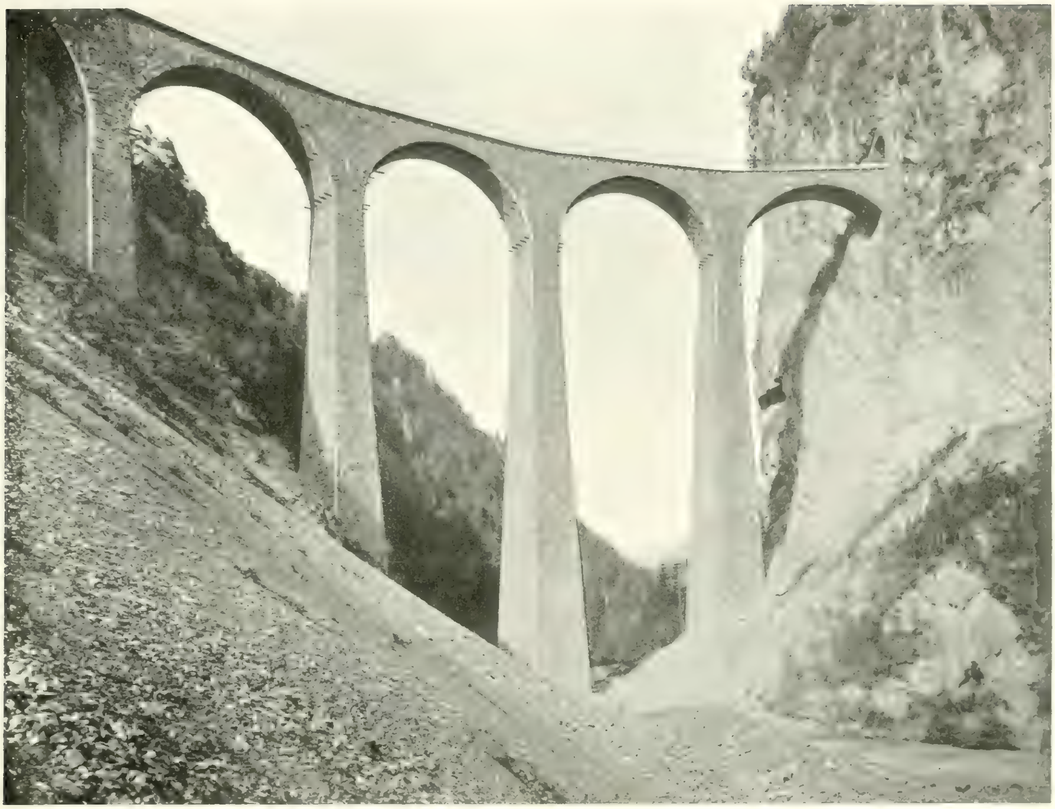
	Summit.	Length of summit tunnel.
Albula (narrow gauge)	1,823 m.	5,866 m.
Arlberg	1,311 ..	10,250 ,,
Mont Cenis	1,295 ,,	12,849 ,,
St. Gothard	1,155 ..	14,984 ..
Semmering ..	898 ..	1,430 ,,
Simplon (under construction)	704 ..	10,770 ,,
The three large tunnels of the Austrian Alpine railways under construction, viz. :		
Gastein line	1,225 m.	8,470 m.
Karawanken line	630 ..	7,943 ..
Wochein line ...	523 ,,	6,365 ..

DESCRIPTION OF THE LINE.

The line at about the fortieth mile joins at Thusis (700 metres above the sea level) the railway line Landquart-Thusis, opened in the year 1896. It passes the Fore-Rhine by an iron girder-bridge 83 metres long, leaving this friendly valley to enter that of the wild and deeply cut Albula. The bridge over the Fore-Rhine, by Bell at Kriens, near Lucerne, is the only one built of iron throughout the whole line. All the others are built of the excellent stone which is quarried in these Alpine regions, and from an artistic standpoint this is fortunate, as stone bridges and viaducts harmonise much better with the scenery than constructions of iron and steel. After a glance at the Heinzenberg, which has been described as the most beautiful mountain of the world, the traveller is greeted by the Domleschg, which has more than twenty ruins and castles scattered over its green fields. The railway then enters the gloomy glen known as the Schyn from which the white Albula issues. In this narrow glen the Schyn highway could only be constructed by numerous blastings and by conducting the road under protected galleries. In consequence of the windings of the river, and the dangerous



A LARGE CURVE BELOW PREDA.



VIADUCT OVER THE LANDWASSER, NEAR FILISUR.

condition of the ground one-third of the rail to Tiefenkasten had to be conducted in tunnels, repeatedly crossing the valley over sloping bridges.

In a continuous ascent the track by larger and smaller tunnels pierces the out-works of the stony mountain. The torrents and rivulets are crossed by arch-bridges up to 30 metres in width. At Solis a green little oasis in the wilderness, the traveller arrives at one of its greatest *pièces de resistance,* an arch bridge 40 metres in width across the river Albula, which rages 90 metres below in the abyss. From this bridge to Tiefenkasten the line has been constructed in a hitherto inaccessible glen. The contract stipulated that the villages on the railway track which are situated at a considerable elevation, like Sils, Solis, Tiefenkasten, Surava and Alvaneu, should be connected by means of special roads. From the latter the station houses nicely built in the Swiss style look extremely picturesque.

At Tiefenkasten—a main junction of the cantonal highways—the village is situated in the depth below the railway, which continues in an even track along the green slopes. Here an uninterrupted view is afforded of the shining mountains grouped in the direction of Davos.

Beyond Bath Alvaneu the route becomes more difficult. The gully of Schmitten—a deep and rocky glen which may easily be recognised as the home of the "wild huntsman"—is crossed by a viaduct 140 metres in width and 35 metres in height, and immediately afterwards the river Landwasser coming from Davos is spanned by the most important bridge of the railway, which forms a keen arch 100 metres in width, the six piers being 65 metres high. From this point one of the finest views of the whole line is afforded. A three-cornered star of valleys is seen here, and through rich side scenes the traveller is impressed with the magnificence of the mountain scenery of the Piz d'Aela. After the darkness of a tunnel the parochial village of Filisur, 1,084 metres above the sea level, with its peculiar stone houses, is seen below. The proud Crochetta rock and the picturesque ruin Greifenstein seem to protect the friendly village. The high track of the railway above this point was unhappily one of the conditions involved in the later junction to Davos through the Bärentritt valley. Even a non-professional traveller can appreciate the difficulties and dangers encountered in the construction of the railway after this point. The real Alpine line now commences.

By turns and loops, and by the steepest gradient possible, the track leads now above the highway, then below the highway, through the Bergünerstein, famous for its gullies and rocks, which may be compared with the Via Mala, to Bergün (1,376 metres). Abruptly emerging from rocky defiles, the train passes Bergün, which presents itself like a bright oasis on green Alpine fields surrounded by the giant Albula Dolomites, Piz Rugnux, Piz d'Aela, and the Albula-horn. During the last part of this collossal panorama of nature, the railway entirely follows the slopes of the mountains, and the Alpine valley surrounded by steep rocks affords new wonders at each turn. Between the stopping places of Muot and Naz, parts of the railway may be seen above, below, and on each side with its chains of viaducts, galleries and bridges, the line often appearing where it is least expected.

It is almost impossible to follow the convolutions of the line, as by threefold turns and loops it passes through tunnels suggestive of the St. Gothard and the Brenner railways. After ascending more than 400 metres the line reaches the entrance to the main tunnel at the lonely Alp Preda.

THE MAIN TUNNEL.

The track is in its last part a phantastic play of turns and loops. We are still in the Albula valley, but three hours' march from the dividing of the Rhine and the Inn Waters. From here, by an easy ascent, one reaches the pass of the Weissenberg, with its lake—a scene of singular beauty, and the Teufelstal (Devil's valley), where the steep basin of rocks is crowned by the twin giants (Piz Giumells). Here the Albula chain is pierced by a tunnel 5,866 metres long, 1,823 metres above the sea level, and 1,000 metres under the Piz Giumells, passing the dividing ridge between the waters of the Rhine and the Danube—the highest railway track in Europe. From Spinas on the eastern slope, the line at the entrance of the tunnel, being protected by special constructions and sheds against avalanches, from the sharp and steep Cresta Mora, enters the beautiful valley of Beverin, which is snow-covered even in the middle of summer. Then by a sharp turn of 90 degrees it reaches Bevers (1,714 metres) in the wide open Engadin valley. After the gulleys and glens of the picturesque North-Western part of the Albula chain, the view to the south and south-west presents an interesting contrast, and there is for the first time seen the white light of the majestic snow-covered giant mountains of the Bernina and the Piz Linguard. Below there is an almost treeless country and a pleasant contrast of green fields. From Bevers the railway follows the left bank of the valley, and after an almost horizontal track of three kilometres reaches Samaden (1,709 metres), the chief place of the Upper Engadin. The tunnel was pierced on May 29th, 1902, arrangements being made for the opening of the line to Samaden on July 1st, 1903.

CONTINUATION TO ST. MORITZ.

The continuation by the Celerina (1,783 metres) to St. Moritz (1,778 metres) is only six kilometres in length. Owing to prolonged negotiations as to the situation of the terminus in that place, its construction could not be commenced last year. It has now, however, been definitely decided to terminate the line in a bay of St. Moritz Lake below the Hotel Belvedere, so that at no distant date the rapid construction of the remainder of the line and its opening for traffic should be effected.

The Swiss engineers will this year hold their general meeting at Chur, and will not fail to offer a hearty welcome to all who are interested in the Albula-Engadin Railway, which can certainly claim to be one of the most interesting engineering achievements of modern times.

A
WIRE ROPEWAY
IN THE
ANAIMALAI HILLS

BY

HORACE H. GASS,

Indian Forest Service.

THE utility of wire ropeways for transport is, perhaps, nowhere better exemplified than in countries possessing valuable products, which are locked up for want of capital and enterprise to establish suitable lines for export over rough and inaccessible territory.

In India, for example, there are vast forests in mighty ranges of mountains, far removed from lines of railway and the road systems of the lowlands, containing valuable timber trees, many of which are little known at present, but which, with cheaper means of extraction, will in course of time, as the reliable woods become more difficult to obtain, find a ready sale in the home markets for all purposes for which hardwoods are required.

The vast importance of these forests cannot be overstated, and the Government of India devotes close attention to their preservation, maintenance, and improvement, at the same time, not overlooking their commercial possibilities.

The Anaimalais (elephant mountains) of Southern India are an important centre of supply —the forests in this region, though much overworked in the past, still containing a large supply of exploitable wood of valuable species, the principal of which is teak. The climate being unhealthy, this range of hills is almost uninhabited by man, but is infested with wild animals. It is a long distance from the railway, and, though roads lead to the foot in various directions, there is only an indifferent cart-track, with a very steep gradient leading up to the west of the outer slopes, and covering a distance of about 3½ miles. It is here connected with a two-foot tramway line, which runs into the heart of the forest. The line is worked by trolleys, drawn by bullocks. It has rendered good service in enabling larger logs to be extracted with an increased output of timber.

The ghaut road has always been a serious obstacle to work on a large scale, as the forests can only be worked during the rainy season, which extends from about the middle of June until the end of January, partly because of malaria, but principally for want of water. Torrential downpours make the road almost impassable at times by the havoc they cause, and it is so steep that it is not safe to metal it, or the draught bullocks descending the hill would obtain no foothold.

THE OLD METHOD.

Under the system at first employed in working these forests, the huge logs were dragged by elephants from the felling compartments to the side of the tramway, and transported on trolleys to the end of the line, from whence they were sent down the ghaut by bullock cart into a large town about fifty miles distant, to be disposed of by auction sales. All this was costly; the sales were uncertain, and the rates low. To improve them it appeared to be desirable to place the timber on the market in a more saleable form for small purchasers, and to reduce the costs of extraction. The former has been effected by the establishment of a sawmill in the forests, worked by water power, with a pelton wheel, the timber being sawn into marketable size, and the latter, by setting up a wire ropeway or timber-run from the crest of the hills overlooking the plains, in order to dispense with the use of the ghaut road—the most costly section of the journey. The wire ropeway passes off from the lower end of the tramway line, and its lower extremity is close to the main road. The sawn wood is thus conveyed from the saw mill by the tramway direct to the wire ropeway, and in this way reaches the foot of the mountain.

DESCRIPTION OF NEW ROPEWAY.

This wire ropeway has been constructed under the orders of the Madras Government by the Forest Department. The principle is a simple one. A loaded carriage travels down a main fixed rope by gravitation, hauling up an empty carriage on the same rope—the two carriages meet in the centre and are there transferred by an arrangement described below. The descending carriage is controlled by an endless thin hauling rope adjusted below the main rope, passing twice round a brake drum, and kept in check by a powerful brake strap, and a large deeply grooved wheel at the foot. Fig. 1 shows the brake drum from the front.

The thin hauling rope is clipped on to the two carriages on the right hand side, looking in the direction in which each is travelling.

The ropeway between the terminals is 6,318 ft. long, and the length of line actually traversed by the carriages, 5,284 ft.

It became necessary to advance the starting platform sufficiently to bring the central or transfer platform on to a ridge within easy reach of the rope The total fall from terminal to terminal is 1,031·58 ft.; that from the upper terminal to the starting platform, 109·50 ft.;

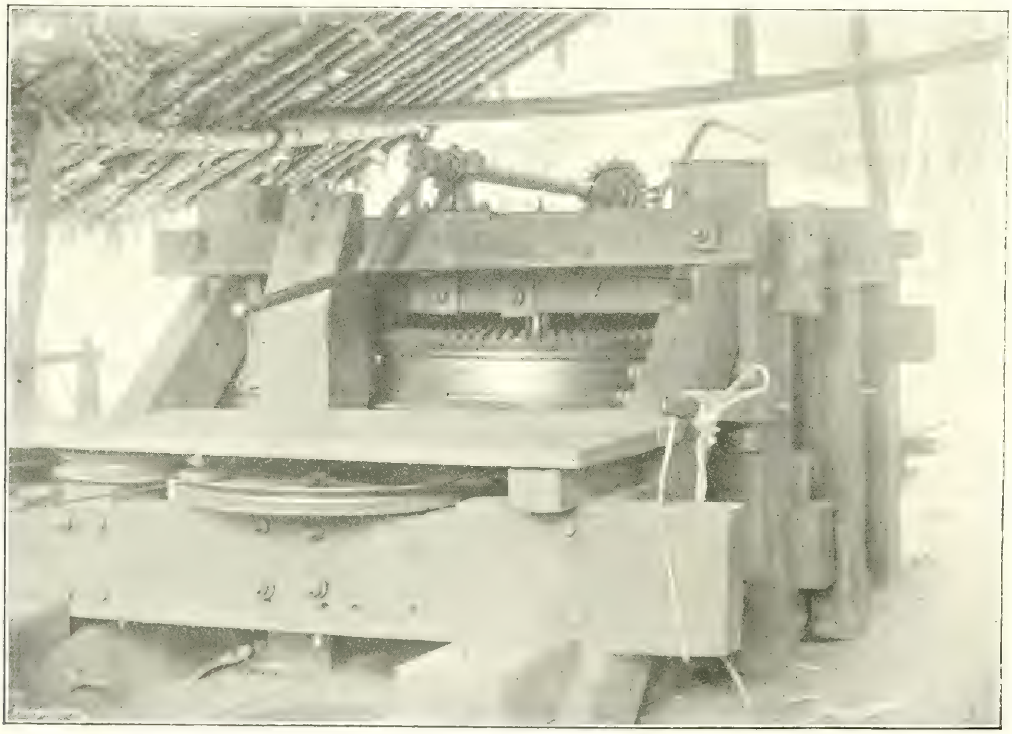


FIG. 1. THE BRAKE DRUM.

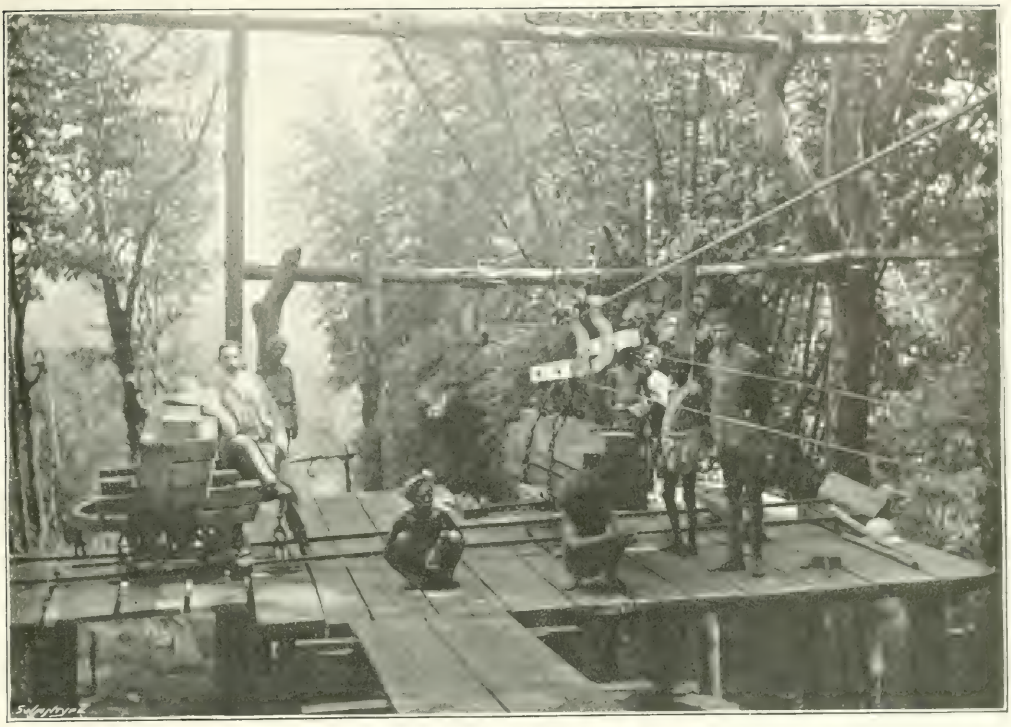


FIG. 2. METHOD OF LOADING AND HAULING.

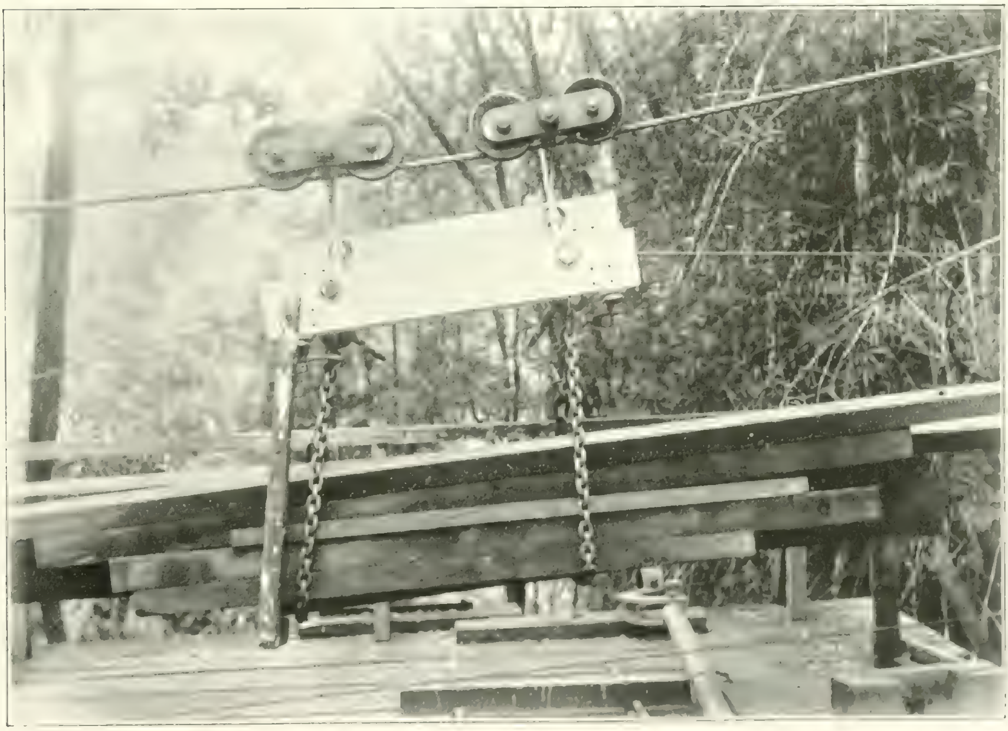


FIG. 3. A DESCENDING CARRIAGE.

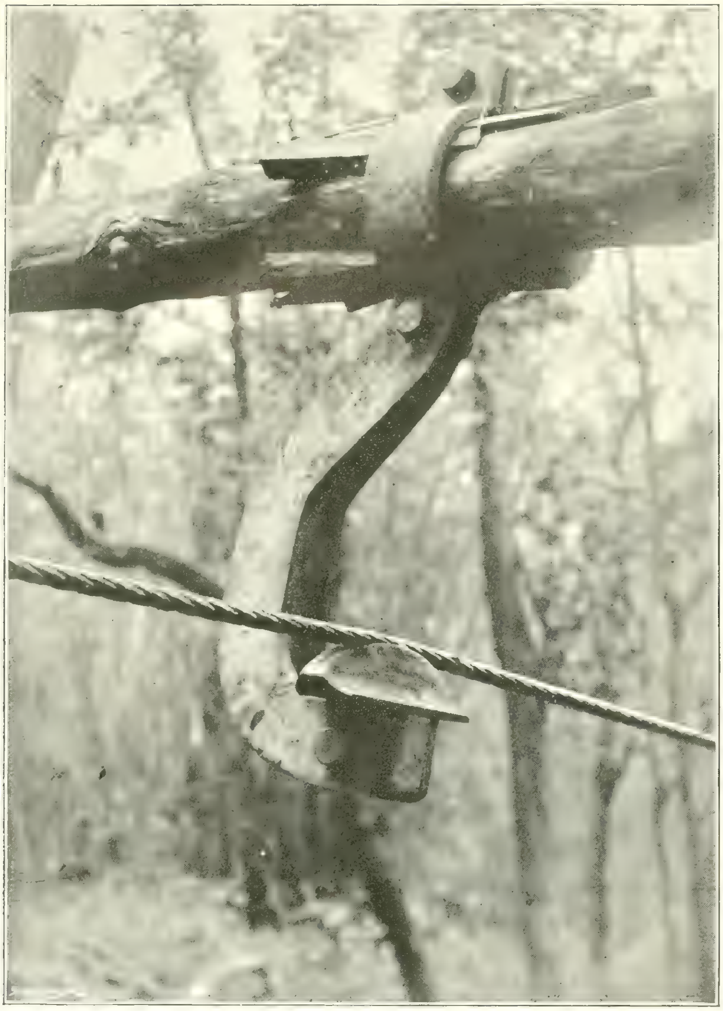


FIG. 4. A HANGING SUPPORT.

from the starting platform to transfer staging, 488·70 ft.; from the transfer station to the lower terminal, 433·38 ft. The rope crosses two main valleys and a number of ravines, the ground being much broken up and rocky in parts.

The rope is supported in eight places up to the starting platform, and in twenty-three between it and the foot. The supports in the former consist of wooden grooved saddles resting on crossbars, and in the latter of hangers and cast iron saddles.

There are six main spans of 554, 1,675, 510, 600, 355, and 712 feet respectively. The fixed rope is $2\frac{7}{8}$ in. in circumference, with six strands and a hempen; each strand contains seven wires of best steel.

The thin, or hauling, wire rope is $\frac{7}{8}$ in. in circumference, with five strands and a hemp core, and each strand contains four wires. This rope can be seen in fig. 1. The brake drum is 4 ft. inside diameter.

The brake strap is adjusted to the upper half of the drum, and acted on by a handle at the side. The lower part of the drum is housed with hard-wood, and hollowed out to prevent the folds of the rope overlapping. The axle of the drums run easily in deep substantial bearings. The large grooved wheel at the foot is also 4 ft. in diameter, but calls for no special description.

The hanging supports consist of two curved wrought iron plates, 3 ft. long, forming a circular opening at the top, 8 in. in diameter, and connected at the bottom by a grooved saddle, in which the rope rests, sloped at the ends to prevent injury to the rope. Fig. 4 shows a support clearly.

The saddles are of cast iron, of similar make, and are used in a few places, resting upon wooden brackets and supports projecting from them conveniently near the line.

THE CARRIAGE.

The carriage consists of two curved wrought iron hangers, connected together by pieces of timber with grooved runners, 9 in. in diameter to the edges, with $1\frac{1}{2}$ in. grooves—the carriages were first used with two wheels, as shown in fig. 2, but experience has shown that it is best to use four wheels, as shown in the following figure.

Four patent clips are attached to each carriage, two to the bottom side of each connecting block. It has been found more convenient to have them attached to the bottom than to the sides.

Each clip is provided with a clamping screw. Fig. 3 shows two clips, and the hauling rope attached to the right-hand side of a descending carriage.

The nearer the wheels are brought together the more easily the carriages will travel. When they are placed some distance apart they do not travel in the same plane, and set up much friction on the rope.

The plant was designed and constructed by Messrs. Bullivant and Co., Ltd., of 72, Mark Lane, and the materials are of the best description, a fact which will be fully recognised when it is stated that until lately the longest span was 2,212 ft. horizontal distance, and that loads weighing about 1,400 lb., exclusive of the weight of the carriage (about 400 lb.) have been sent down in large numbers quite safely.

CONSTRUCTION OF THE LINE.

The first step towards the installation of the wire ropeway was the selection of the most convenient line, and laying it out and clearing it—a by no means easy matter, as it lay through heavy forest. The supports were then set up.

The anchorages were next prepared, and as there was no natural rock in the right place, large boulders, each weighing about fifteen tons, were dragged by elephants, and dropped into position at each end of the line. Holes had then to be drilled in the boulders for the legs of the iron anchor bars—4 ft. in length and 3 in. thick. Two massive cables, 24 ft. long, for the upper anchorage, and 12 ft. for the lower, were then attached to the anchor bars, and the latter were firmly fixed in the rocks.

The unreeling of the rope followed, commencing, of course, from the bottom of the line. This was received from Messrs. Bullivant and Co. on a large iron reel or bobbin, the total weight of the rope and reel being about four tons. An axle was passed through a hole in the centre, and the reel was swung clear of the ground.

It was first intended to carry the rope up the hill on the shoulders of coolies, placed at intervals of 30 ft., but the broken nature of the ground made this difficult to carry out, and eventually elephants were attached to the end of the rope to haul it up. The friction caused by the rope dragging along the ground was, however, so

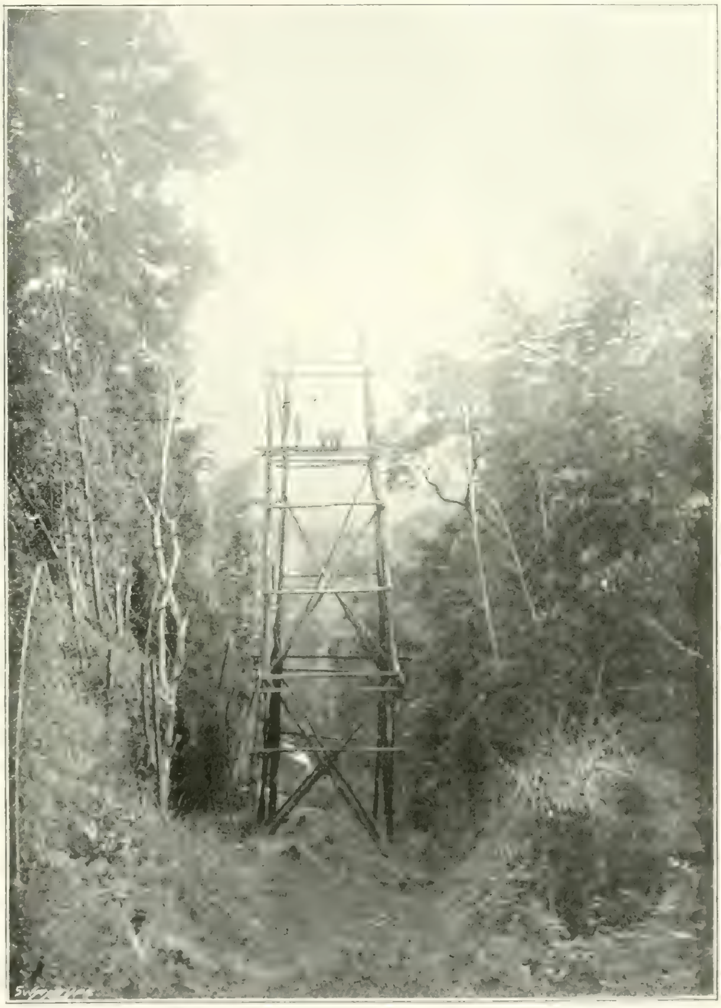


FIG. 5. THE CENTRAL OR TRANSFER PLATFORM.

great that at the end of the journey no less than nine elephants were used in addition to a large body of coolies.

Spliced into the end of the rope was a massive thimble, or eyelet. This was attached to the chain, and the rope was fixed to its upper anchorage. It was then raised on to the supports and connected on to the anchorage cable at the lower end, and hauled in by means of a small winch, provided with the necessary two and three sheave blocks and best flexible rope. Sufficient tension was obtained to give a dip in each span of about 1 in 40.

The unreeling of the hauling rope followed, and the two ends were joined. This rope is, of course, adjusted below the fixed rope, and is drawn reasonably tight. The up and down sides are arranged 18 in. apart, corresponding with the distance between the inner edges of the clips on the carriage, and kept in that position by means of fixed guide wheels, which lead the rope to the drum (shown in fig. 1) and large wheel at foot. It was a matter of some difficulty to overcome the friction set up on this rope, which, of course, checked the loads. The design of rollers had to be changed several times, the last and most successful being large grooved pulleys, about 18 in. in diameter, running easily on their bearings, and provided with wooden guides placed above them to lead the thin rope into the grooves.

The supports for the hangers and saddles vary in height from 8 ft. to 75 ft., and consist, as a rule, of two uprights and a stout 8-in. crossbar. In a few instances standing trees have been utilised as uprights. Fig. 5 shows the highest upright, 75 ft. from ground to top of saddle, and this support is the upper end of the longest span of 1,675 ft.

The best positions for the supports have been ascertained by experience alone, various changes being necessary before a constant fall was secured. The very long span was necessitated by the configuration of the ground, and as the rope is about 200 ft. from the ground in the middle of this span, it will not be possible to break it.

THE PLATFORMS.

There are four platforms. (1) The brake plaftorm, 22 ft. by 15 ft., is placed 30 ft. to the rear of the starting platform. (2) The starting platform, 19 ft. by 20 ft. (fig. 2) is provided with tram rails, at the end of which is a weighing machine to ensure constant weight in the loads. (3) The central, or transfer, platform is 40 ft. by 8 ft., and 4 ft. high, and placed at a distance of 10 ft. from the line of the fixed rope.

A trolley runs on this platform provided with a long wooden lever supported by a chain. A crossbar is attached to the end of this lever, corresponding in length with that of the carriage, and fitted with two upright iron plates to pass in between the wheels and the hangers of the carriage.

The height of this platform is so arranged as to bring the lever when horizontal, to nearly the level of the carriage. This is illustrated in fig. 5. (4) The lower platform is 28 ft. by 8 ft., and 5 ft. high, and requires no explanation. The height is conveniently arranged with reference to that of the fixed rope.

METHODS OF WORKING.

The method of working the rope is as follows: The weight of a load has hitherto not been allowed to exceed that of about 22 cwt., or about 1,400 lb. of timber, and, though it is possible to send down rough logs of that size, the work has been confined to the transport of railway sleepers and sawn scantlings of different sizes.

Fig. 6 shows a loaded carriage passing a hanger, and that the construction of hangers, of supports, and carriage, enables this to be done with safety and ease.

Fig. 2 shows a load of seven railway sleepers attached to the carriage, and the next load ready in the trolley. In that picture the hauling rope is shown clipped up on both sides of the carriage, which anchors it firmly. As soon as it is ascertained that all is ready below, that is to say, that the previous load has been removed and the thin rope clipped on to the empty carriage ready for the ascent, the hauling rope is detached from the left-hand side of the loaded carriage and lowered on to the rollers below, and the carriage is started, descending at high speed, some twenty miles an hour, to the central station, and kept under control by the brake drum. The two carriages meet here, and are

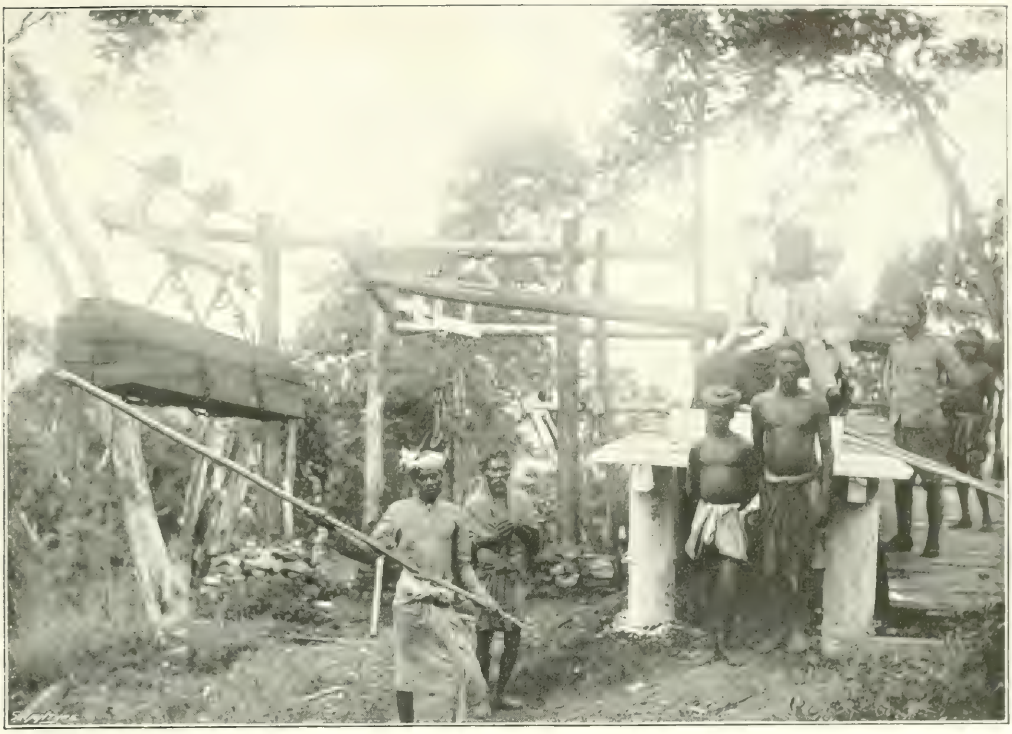


FIG. 6. A LOADED CARRIAGE PASSING A HANGER.

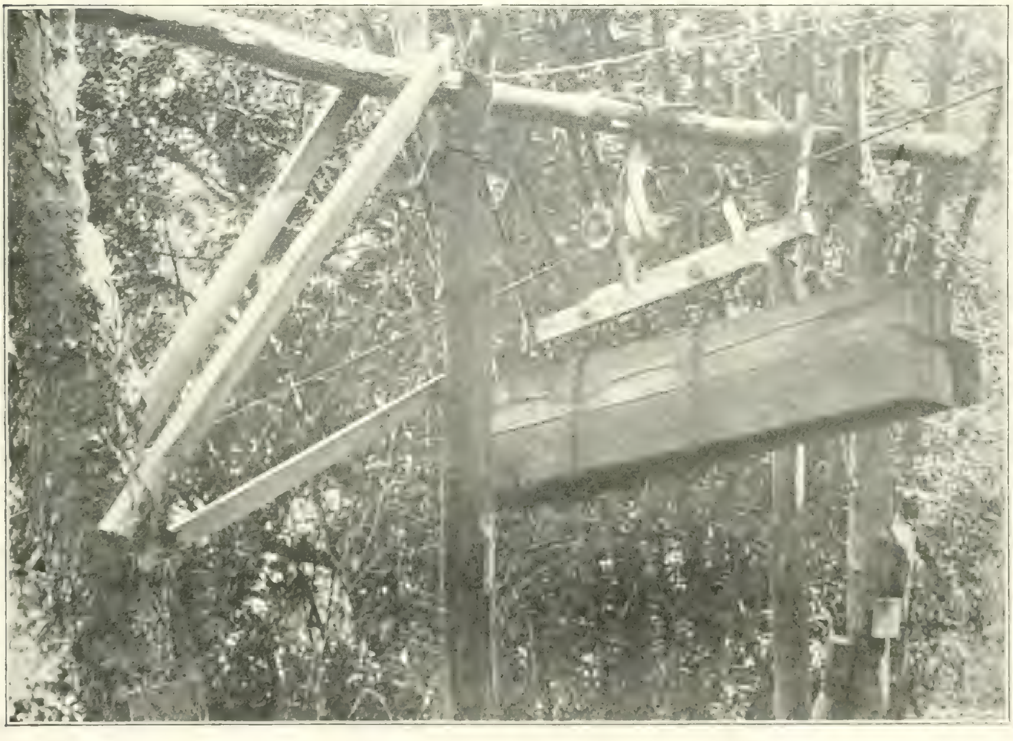


FIG. 7. ILLUSTRATING THE ACTION OF THE LEVER GRIPPING AN EMPTY CARRIAGE.

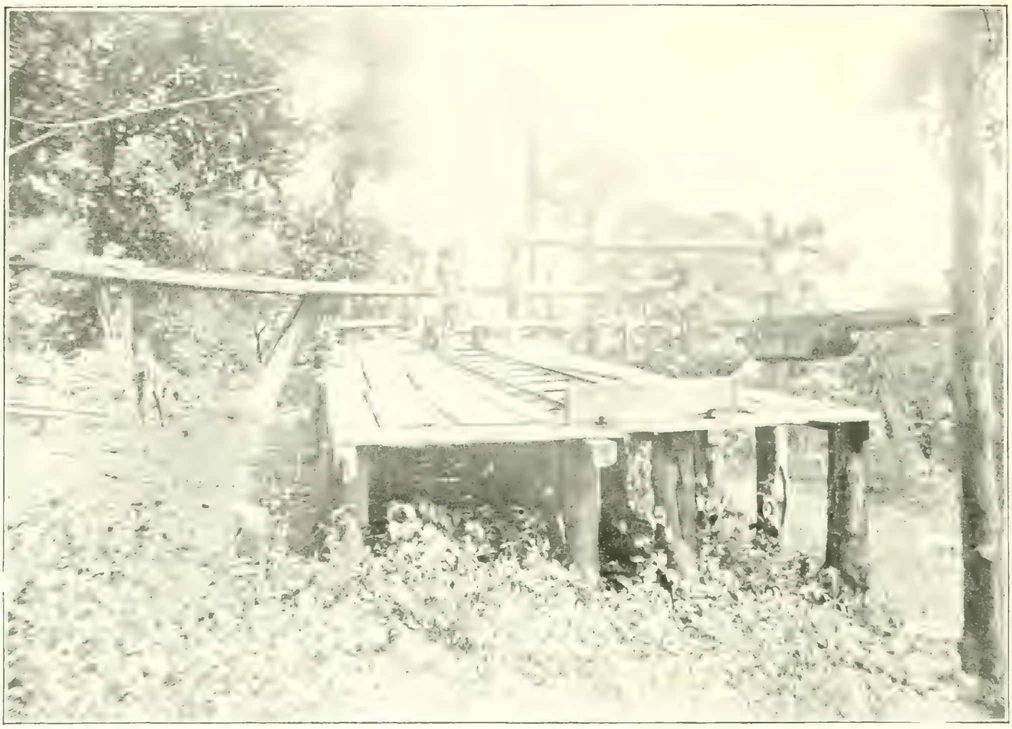


FIG. 8. EMPTY CARRIAGE ABOUT TO BE REPLACED ON ROPE.

stopped at a distance of about ten feet or more, according to the length of the scantlings. The trolley and lever are then brought opposite to the empty carriage, and the crossbar engages it, the outer end of the lever is pressed down to raise the grooved wheels off the rope and then pushed forward for a few inches to clear the rope. The lever is then raised at the end, and the empty carriage with the hauling rope attached to it, falls downwards slowly, till it is low enough to clear the loaded carriage. The latter is then advanced slowly, and the trolley, with the empty carriage comes forward on the rail a corresponding distance, and by means of a lever the carriage is raised and replaced in the rope.

Fig. 7 illustrates the action of the lever gripping the empty carriage, and fig. 8 shows the empty carriage about to be replaced on the rope after the two carriages have changed places.

The slow forward movement of the loaded carriage is obtained by means of a brake drum which is now provided with gearing, as shown in fig. 1, and the drum is slowly revolved by hand.

The carriages are again started, and the arrival of the empty carriage at the starting platform indicates that the load has reached the foot.

The supporting chains are provided with a hook and ring always placed on the outside, so that they can be released at once, and the load becomes detached. The hauling rope is then removed from the clips on the right-hand side, and the up rope is placed on those of the opposite side of the carriage, the same procedure being followed at the starting platform, and the new load is immediately attached, after taking the precaution referred to above to prevent the carriage starting prematurely.

The line is kept clear of growth, and the starting platform is so arranged that the central platform is easily visible from it. Flag signalling is found to be the quickest, easiest, and safest method, and the brakeman is kept under control by the look-out man on the platform.

The method of transferring may appear to be somewhat primitive, involving the use of superfluous manual labour, but, after careful consideration, it is found to be the best means of working, and is preferable to an automatic arrangement, which would be certain to come to grief continually and cause both carriages to fall off the rope. The lever arrangement works well and expeditiously.

THE OUTPUT.

The loads can be run down at the rate of about two to the hour, and the saving is very considerable, so that if it were possible to work throughout the year with sufficient material, this ropeway would show a handsome profit. Its output of work is far in excess of that of the sawmill, and it can be worked in all weathers.

The carriage of 20 cwt. of timber down the ghaut section of the road, inclusive of loading unloading, and returning, would occupy about two days, against the half-hour of the wire ropeway. Once at the foot of the hill, there is little difficulty in moving on the material, as bullock carts can always be obtained in the plains. It is the hill portion of the journey into the forest which the cartmen dread and will not undertake in the bad weather.

SPECIAL PRECAUTIONS.

It was at one time feared that damage might be done to the ropeway by wild elephants, as the hauling rope is quite close to the ground in many places, but, though they are often on the line, no damage has been done hitherto. Forest fires were also feared, but precautions, by burying the rubbish on the line, are and can always be taken.

The exposure of the rope to the weather is detrimental to it, but is minimised by periodically lubricating it in its entire length. There is more wear and tear on the rope in the places where it rests on the supports than between them ; this is reduced by rubbing on grease.

CONCLUSION.

The ropeway has been a great success, but its construction in such a part of the country was beset with difficulties, because of the heavy weight to move and the absence of expert labour, the only available labour consisting of the aboriginal tribes.

The system of working is the best possible. The single rope was adopted in order to save expense, and as the working season is short, and the available material easily transported, it does all that is necessary, and the addition of a second rope may well be deferred for some years until the present rope is sufficiently worn to be unsafe for heavy loads, when it can be used for the up-going empty carriages.

The advantages of such a ropeway are so great that it is surprising that more are not in use. In places where work can be carried out on a large scale, the saving would be so considerable that the initial outlay would be of little importance. As a fact, too, considering the quality of the materials, and their durability, the cost is small.

With the experience gained, to facilitate construction, and given a sufficient fall and suitable ground for the erection of supports, no better or more economical means of transport could well be desired.

THE NEW PRESIDENT OF THE INSTITUTION OF MECHANICAL ENGINEERS.

J. HARTLEY WICKSTEED, Esq., M.Inst.C.E.

Photo. Lafayette.

J. HARTLEY WICKSTEED, ESQ., M.INST.C.E.

THE accompanying portrait of Mr. J. Hartley Wicksteed, Chairman of the Leeds firm of Joshua Buckton and Co., Ltd., taken since his election as President of the Institution of Mechanical Engineers, will, we are assured, be viewed with interest by a wide circle of our readers the more so because Mr. Wicksteed, although a force in the mechanical world, is inclined to hide his light under the proverbial bushel. It is also timely in view of the annual meeting of the Institution at Leeds, and the attention which has lately been given to the important question of the training of engineers—a matter in which the President is keenly interested. Mr. Wicksteed holds that our technical schools and universities should be regarded as the proving houses of the raw material for the engineering apprentice. On a recent occasion he remarked that there were those who thought that scientific education caused an unnecessary expense, and that examinations overstrained the brain and disabled it. There was truth in these arguments if the education and testing were more severe than the physical raw material was able to bear; but without tests they were liable to encumber their works with apprentices who did not possess the inherent qualifications for success and who turned out costly failures. There could be little doubt that the mechanical engineer of to-day needed more education than had sufficed to make him successful in the past. Formerly he rang the changes on the six mechanical powers, with heat, steam, the laws of motion, and hydraulics. Now electricity was added to the chimes, and the number of changes on his peal of bells was multiplied by a fresh factor. Mr. Wicksteed has contributed papers to the Institute of Mechanical Engineers on a single lever testing machine and an autographic test-recording apparatus. In the Mechanical Engineers' section of the International Engineering Congress at Glasgow in 1901, he read an important paper on the 100-ton universal testing machine, with variable accumulator, at the James Watt Laboratories, Glasgow University.

THE
TACTICS OF THE GUN.[*]

BY

LIEUTENANT-COMMANDER A. P. NIBLACK, U.S.N.

The author argues that the key to modern fleet actions is concentration of gun fire, the function of the gun being to destroy the battery and *personnel*. He illustrates the relation between formations and the concentration of gun fire by a series of diagrams, and criticises some of the present tendencies of United States naval construction. Incidentally some interesting remarks are made on the subject of British target practice.—ED.

THE battleship is the epitome of sea power. Reduced to its simplest terms, it is a floating gun-platform. As a unit of offence it contains, on a given displacement, the maximum of concentrated destructive power, (*a*) for battle on the high seas for which it is primarily designed, and (*b*) for coast attack, which is its secondary and seldom-used purpose.

The difference between the tactical values of battleships and of cruisers, torpedo-boats, submarines, and rams are those of degree rather than of kind, for each merely chooses some weapon or some quality of the battleship, and sacrifices everything else to it. The special tactics suited to each are dictated by the battleships. Cruisers, torpedo-boats, and rams must have speed to avoid encountering them unwillingly or to deliver their blow in the shortest time so as to escape as much gun-fire as possible. Submarines must be invisible. On the other hand, in the design of the battleship, we must secure immunity from the other classes of vessels but this is done, as far as equipment, construction, and ordnance are concerned, by quick manœuvring qualities, powerful secondary batteries, search-lights, nets, and other auxiliary appliances; but, primarily, battleships are meant to fight battleships on the high seas, and it is in this view of gun against gun that we shall consider the question of tactics.

It is the function of the ram and of the torpedo to penetrate the under-water body of a ship, and breaking down its water-tight sub-divisions, or striking it in a vital point such as a magazine or boiler, to destroy it. It is the function of the gun to put out of action the battery and *personnel*, but as long as a ship retains her motive power, steering gear, and her *personnel* other than that of the battery, the gun is almost powerless to destroy. To be more explicit, it is only by luck or by indirection that a modern battleship can sink another by gun-fire alone. We need not in the future expect to set ships on fire by gun-fire, as at Santiago or Manilla, and, indeed, we have a long way to go before we can expect to achieve victories over our next adversary. This is a warning and not a prophecy.

CONCENTRATION OF GUN FIRE.

The individual gun is the unit of offence in one sense, but the combined fire of as many guns as possible, directed according to a definite scheme, by means of well organised fire control, alone means victory. The key to modern fleet actions is concentration of gun-fire. To achieve this we must install our guns properly, and we must, of all things, train our *personnel*. Fleet formations should be based on gun-fire, and in battle we should limit tactical movements to those which least disturb it.

The object of all tactical manoeuvres or movements of a fleet previous to or in a fleet engagement should be:—

1. To get and keep the enemy within a close effective range.

2. To endeavour to get a superior position in order to mask some of his fire or increase the effect of your own.

3. To hold an advantage gained, or failing it, to manoeuvre for a fresh one.

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[*] Read at the General Meeting of the Society of Naval Architects, New York.

4. To avoid waste of ammunition;

5. To get out of a position of disadvantage or one in which a move of the enemy may threaten to place you.

6. To concentrate gun-fire on certain ships of the enemy in order to reduce the tactical efficiency of all his ships by crippling one or more.

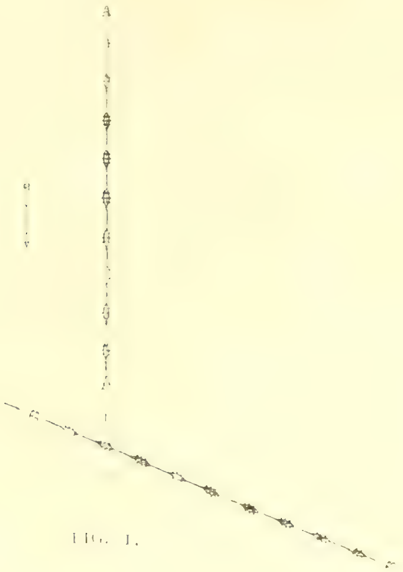


FIG. 1.

7. But of all things to deliver a rapid crushing fire at the earliest possible moment, thereby injuring at once his initiative and increasing your own offensive power in a geometrical ratio as you destroy his.

IN THE SAILING SHIP PERIOD.

Modern steam fleet-tactics differ in many essentials from the tactics of the sailing-ship period and from military tactics on shore. In the days of sailing ships practically all guns were necessarily mounted in broadside, and bow and stern fire, for structural reasons were inconsiderable. The natural formation was column (or "line ahead," as it is called abroad), as this gave the greatest effective fire, viz., broadside. In the approach of such fleets to each other in an engagement, very few guns could be brought to bear, and the preliminary manœuvring was generally to secure the weather-gauge, or windward position, which gave the advantage of forcing the engagement, or withdrawing from it. The supreme tactical advantage was gained by "breaking the enemy's line" (column of vessels), throwing his formation into confusion, raking his nearest ships in passing through, and escaping most of his broadsides while delivering your own successively and in its most effective form. Thus, in fig. 1, the "A" fleet, having the windward position, bears down in column (line ahead) before the wind, and breaks through B's column (or "close hauled line ahead"). In the approach (fig. 1) A's leading ship or ships get the broadside of several of B's without being able to reply with more than a few bow guns, but the danger zone being small, and, once having an opening, the A fleet (fig. 2) goes through, raking B's nearest ships, and doubling down the wing on his disorganised and confused formation.

In an army on shore, on the other hand, line formation ("line abreast," as nautically expressed abroad), must necessarily be the offensive formation, since men must shoot to the front, and hence "bow fire," so to speak, is the only fire. Troops advance on each other, delivering their maximum fire as they approach, and the tactical advantage is gained by turning the enemy's flank, and thus avoiding or "masking" the fire of his centre and of his other flank (fig.3). Military tactics are thus practically the reverse of those of the sailing ship period.

With modern battleships, the installation of pairs of heavy guns in the ends of ships, and the introduction of the ram and the torpedo have changed naval tactics Bow and stern fire is now a little less than 30 per cent. of each broadside fire, instead of about 5 per cent. as in the sailing ship days, and to attempt to break through an enemy's column, as in figs. 1 and 2, would be the height of folly. The leading ships of A, with less than 30 per cent. of their total fire available, would, in attempting to break through, be withered by the powerful concentrated broadsides of B's column, or destroyed by his torpedoes, or sunk by his rams. Then, too, raking fire has lost its terrors because the bow and stern presentation of a modern battleship is very strong owing to its concentration of heavy armour in the casements, barbettes, and turrets. In other words, at close quarters, a raking fire is not necessarily any more disastrous than firing at the broadside.

MODERN TACTICS.

We thus have in modern steam-fleet tactics a sort of half way, or a compromise, on sailing ships and military tactics, for "to turn the enemy's flank," as in the army, is a good manœuvre; the approach to the attack in line is now feasible, as it gives about 30 per cent. of gun fire; and column, as in the past, is the formation giving maximum effective gun-fire. As stated before, the function of the gun is to destroy the battery and *personnel*, because armour and the water-tight sub-divisions make it well-nigh impossible

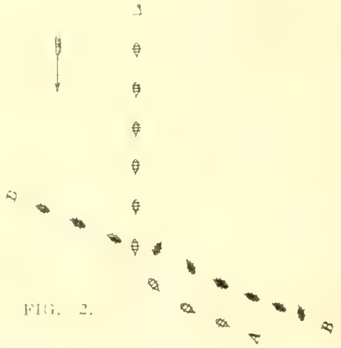


FIG. 2.

to reach the vitals of a ship with gun-fire alone, except with plunging fire at long range, and destruction is the function of the ram and the torpedo. (Incidentally, as will be shown later, it is the large port openings and failure to isolate gun positions in most of our battleships that constitute sources of peril with an enemy that can shoot.) To state the general proposition more in detail, with steam and modern improvements—

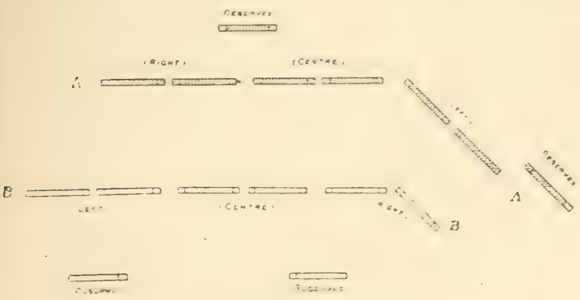


FIG. 3.

1. Bow fire has become a great factor in modifying tactics.

2. The ram is more than ever a dangerous and fatal weapon.

3. Armour has almost nullified the great danger from raking fire at close quarters.

4. The torpedo has made it dangerous to fight at closer range than 1,000 yards.

5. Smokeless powder and high speed make the windward position of little importance compared with getting the sunlight on the enemy and in his eyes.

6. Elaborate sub-divisions in ships tend to prolong the time and increase the difficulties of the destruction of a ship by any weapon.

To illustrate the relation between formations and the concentration of gun-fire, a series of diagrams are appended. In the unit battleship, as in fig. 4, it is considered that a ship can bring her whole broadside to bear 45 deg. forward or abaft the beam, and, for convenience, we will consider only one broadside at a time. The bow and stern fire is 30 per cent. of the broadside. With a number of ships in column, as in fig. 5, the area of maximum concentrated gun-fire is abreast the middle ship and at a distance equal to half the length of the column. The nearest that ships can steam in column, and do anything else, is 200 yards interval, or "half distance," as we call it; and it is important to note that, in this case, with nine ships, the distance of the area of maximum concentrated gun-fire is 800 yards, which is quite easily within torpedo range to-day. I am personally mentally incapable of understanding the reasoning which has led the Board on Construction, in the Navy Department, to leave under-water discharge torpedo tubes out of the recently designed battleships and armoured cruisers. (We have them only in the *Maine*, *Missouri*, and *Ohio*, of all our ships in the Navy.) Everyone regards above-water torpedo tubes, in such ships, even behind armour, as rather dangerous, but with, as I believe, the very best and safest under-water discharge system, and with either the new modified Obry or the Kaselowsky attachment fitted to torpedoes, it is inconceivable that anyone can argue against under-water tubes for modern battleships. In fact, a ship is not a battleship unless she has them. I have personally seen under-water discharge abroad with our type of tube and the modified Obry gear, with 1,000 yards run in this country, and I have as much faith in the accuracy and reliability of the torpedo as I have in the 12-in. gun. Modern fleet tactics demand the torpedo. Its mere presence on board limits the range at which gun-fire may be used in single-ship actions or in fleet engagements, and just when the torpedo is beginning its development it seems to be a poor time to dispense with it. A battleship disabled in her battery, but intact below the waterline, is an ugly problem if her ram and torpedoes are also intact. She is still capable of sinking one or more battleships if desperately and skilfully handled. I repeat, it is a grave mistake to leave these tubes out of our ships, and I earnestly hope the Secretary of the Navy will intervene and save us from the results of this short-sighted policy. Twelve feet between bulkheads will give us ample space to operate a tube on each side, and, as we may soon see torpedoes with 1,500 yards range, it behoves us to retrieve, as far as we can, our mistake in this particular.

SOME FUNDAMENTAL PRINCIPLES.

In fig. 6 we see that the area of maximum concentrated gun-fire of a fleet in line is near the centre ship. The two flank ships are firing the forward broadside guns just clear of their next in line, and all others are using bow fire only. In fig. 7 the various formations are on lines of bearing two points (22½ deg.) apart. The fleet is first supposed to be in line, as in fig. 6, and by pivoting on F to change the line of bearing to the right two points at a time until column is reached, as in fig. 8. This diagram is for both batteries, and is very suggestive. For instance, with the starboard battery, a change of two points from line to the second position throws the area of maximum concentrated gun-fire from *a* to *b*; two points more to *c*, two points more to *d*, and in column to *e*. Whereas with port battery, the positions *a'*, *b'*, *c'*, *d'*, and *e'* are relatively close to each other. The pivot or guide ship F should thus

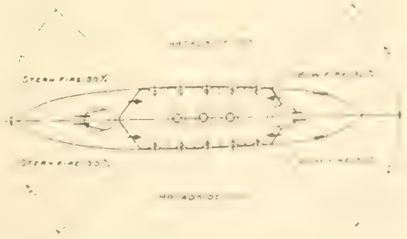


FIG. 4.

be the one on the flank nearest the enemy in order to least disturb gun-fire in changing lines of bearing for tactical purposes. In each of the four quadrants of a circle about F as a centre, the port battery will alternate with the starboard in being the better battery. These formations are worth studying, for it is on gun-fire that modern tactics must be based. Such sayings as "Gun-fire is everything," and "The best protection against gun-fire is a well-directed fire from your own guns" are fundamental principles.

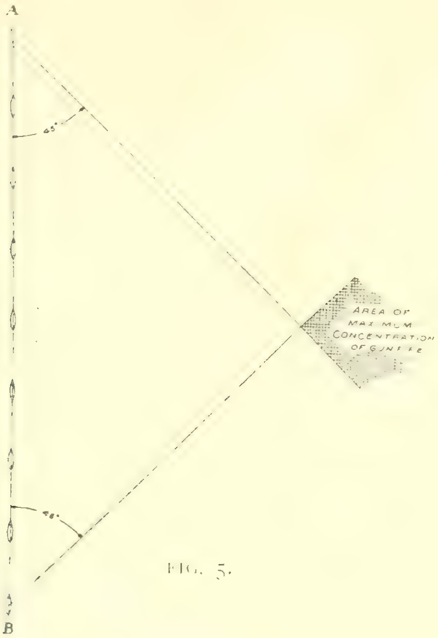


FIG. 5.

PROGRESS IN THE BRITISH NAVY.

Few people realise the horrible destructiveness of modern gun-fire. Our fleet at Santiago accomplished what it did with less than 4 per cent. of hits, and at that time our Navy had the reputation of having the best gunners in the world. Since then both ordnance and gunnery have been almost revolutionised, so much so that guns and methods good enough for 1898 are an invitation to-day to disastrous and bitter defeat. To illustrate how gunnery has improved and how terrible must be the hail of projectiles in a modern fleet engagement, let us briefly notice the recent progress made in the British Navy in the matter of target practice. Let us take first the 6-in. guns, as shown by the annual prize-firing contest for 1901.

Each ship steamed at a speed of twelve knots, and fired for two minutes with each 6-in. gun, firing one gun at a time, at a target 20 ft. long and 16 ft. high, at a distance of nearly a statute mile. As published in the British press, and verified by official reports, in 1901 the average of forty-eight British ships was nearly two hits per gun per minute. The best fifteen of the forty-eight made from two to four hits per gun per minute, but the best individual record was a string of eight shots and eight hits in one minute.

THE WORLD'S RECORD.

The record in the British Navy for 6-in. guns for the year 1902, so far as published at the time of writing, is as follows :—

No. of Guns.	Name of Ship.	Shots.	Hits.	Per Minute.		Percentage of Hits.
				Shots.	Hits.	
12	Ocean .	163	117	6·79	4·875	71
12	Crescent ...	139	105	5·79	4·375	74
12	Goliath ...	163	71	6·79	2·958	49
12	Terrible .	109	66	4·54	2·750	60
10	Blenheim...	84	50	4·20	2·500	59
12	Albion . .	117	57	4·87	2·375	48
12	Cressy ..	92	52	4·83	2·170	50
Totals 82	. .. .	867	518			

In other words, 82 6-in. guns fired 867 projectiles in two minutes, and made 518 hits, or nearly 60 per cent. The *Ocean* averaged nearly five hits a minute. One of her gun captains fired 9 shots and made 9 hits in one minute. This is easily the world's record, as it means less than seven seconds between aimed shots. One gun fired seventeen shots in two minutes and made fifteen hits. It will be seen that the percentage of hits does not determine the standing of a ship. It is the number of actual hits per gun per minute.

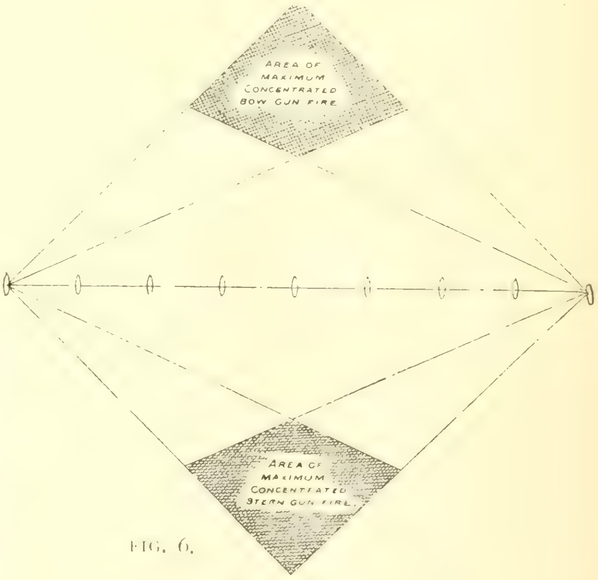

AREA OF MAXIMUM CONCENTRATED BOW GUN FIRE
AREA OF MAXIMUM CONCENTRATED STERN GUN FIRE

FIG. 6.

In smaller calibre guns one ship, in 1901, fired 159 shots in one minute from her 4·7-inch guns, and made 114 hits or 7·5 shots and 5·7 hits per gun per minute.

In larger calibres, the *Ocean* this year (1902) made 68 per cent. of hits with her 12-in. guns, and one ship in the British Navy has a record of 8 shots and 7 hits with her 12-in. guns in five minutes and thirty seconds. Indeed, the established firing interval for British 12-in. guns is about forty-eight seconds.

THE NEEDS OF THE UNITED STATES NAVY.

It is very evident that since gun-fire is intended to put out of action the battery and gun's crews of other ships, that the gun positions must be well protected against such fire as is now possible, and which we have apparently not reckoned on. Can we afford to let such ships as the *Kearsarge* and *Kentucky* remain as they are with such large port openings and with their 5-in. guns in open casemates? Even in the *Alabama* class the gun-recoil cylinders are exposed to danger from small projectiles or fragments of shell. Must we not come to the foreign practice of mounting our 5-in. and 6-in. and 7-in. guns in closed or isolated casemates, each with its ammunition supply? In our newer ships the turret mountings are excellent, but we have sacrificed in the smaller guns the question of protection to that of numbers. We have always given our ships heavier batteries than corresponding types abroad, and we have kept pace with the progress in initial velocities, but I am beginning to think that the Germans have pursued the safer course in keeping their guns of standard pattern and of smaller calibres and lower muzzle velocities.

The problem of brass cases *v.* loose charges; of metallic *v.* plastic pad obturation; of electric *v.* percussion firing; of the form and mounting of the telescope-sight and of its graduation; of the rapidity of elevation and train of guns; of loading at any angle of elevation—all these are but a few of the pressing questions in ordnance. In training men to shoot we are baffled by the continual change in the *personnel* of our ships; in the strain on officers and men due to the undermanning of our ships; in the constant drive to make an adequate number of ships constantly shift about all over the world to meet political and other emergencies which directly prevents target practice; and also by inadequate appropriations for gunnery exercises.

In the next war the Navy must bear almost the entire brunt. There is a disposition in Congress and in the country at large to let up on our naval expansion. History teaches the folly of such a course and reason tells us that we are courting humiliation. We need more officers and men, the batteries of ships being the basis of computation, and the battleships and armoured cruisers the unit.

In the study and formulation of the principles of tactics and strategy we may rest assured that the naval war college at Newport is alive to its responsibilities, and we may now confidently look forward to the day when a general staff will put the principles into execution in case of the appeal to arms to which this country seems to have the habit and for which it is apparently always unprepared. We cannot afford next time to trust to luck and an obliging enemy. There is a healthy realisation in the *personnel* of our Navy to-day of our unpreparedness and of the fact that other Powers know it.

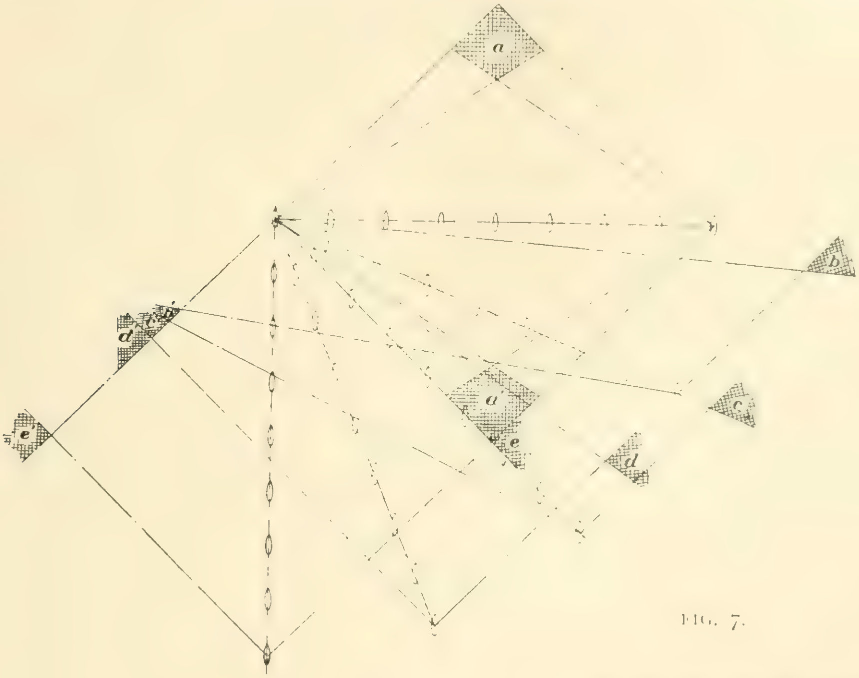
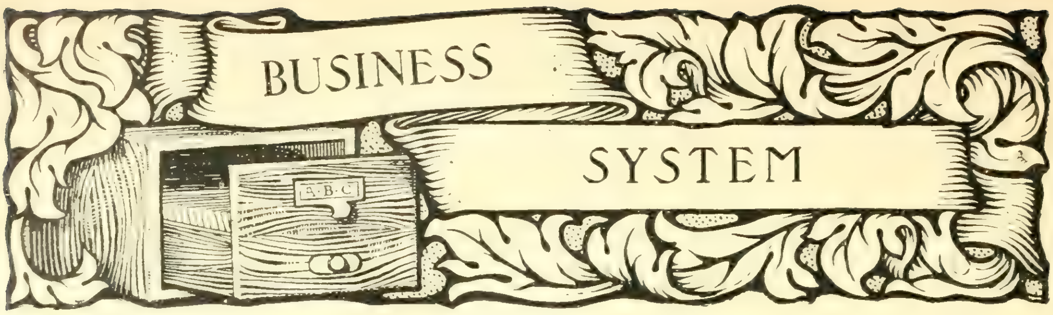


FIG. 7.



BUSINESS SYSTEM AND ORGANISATION

BY

D. N. DUNLOP.

The previous articles on "Business System and Organisation," by Mr. Dunlop, are as follows: "Introductory Article" (July, 1902), "A Simple System of Cost-Keeping in Outline" (August, 1902), "The Cost of Production" (November, 1902), "Cost-Keeping" (December, 1902), "The Question of Labour in Factories" (April, 1903).—Ed.

SECOND SERIES.—II.

STOCKKEEPING AND RECORDING.

SYSTEM in business means perfect organisation; it is the highest expression of business intelligence. System saves time and labour, and insures accuracy and despatch. It must not be imagined, however, that System is a substitute for watchfulness; that it be enough to organise the factory or business on a good system, and leave it to run on of its own accord. System makes watchfulness easy and effectual, and brings about substantial, practical results which are just as important as economy.

Thousands of business men only know once a year whether they are making or losing money, and even then they are left to guess how this has come about, and to grope in the dark for a remedy. Given an efficient system, it is just as easy for a business man to know week by week how his balance stands, what each department has produced, the gross profit, the total expense and the net profit on business transacted.

In a former series of papers, the necessity for accurate cost-keeping was shown; it is now proposed to outline various systems which have proved successful for all departments of the modern organised factory.

There are two forces at work in the modern factory; one productive, the other recording; one objective, the other subjective. In order to obtain a perfect organisation registering success, these two forces must be well balanced, and work together in harmony.

Under the present conditions of commerce, the manufacturer must, in order to cope successfully with the competition which exists in every line of business, completely organise both factory and office, and provide in addition a system of records which will give him at any moment easy and rapid access to every detail of his business without creating extra work thereby or interfering with the operations of machinery or staff.

Approaching the departments in order, the Stores and Stockroom may be dealt with first. The importance of a good system for handling stock and stores is evident when we realise the deplorable results which may be traced to defective organisation in this important department, on which all operations of manufacture are dependent; such results may be instanced as delay in carrying out an order, involving even a temporary shut down of one machine or of the whole plant, the breaking of a contract, or serious and undiscovered loss through waste of material due to the carelessness of workmen or the inefficiency of foremen.

Our subject falls naturally into five divisions, under headings of:—

1. The Stockroom and its Equipment.
2. The Stores and Stock.
3. The Staff.
4. The Records.
5. The System at Work.

THE STOCKROOM AND ITS EQUIPMENT.

The practice of providing a storeroom or rooms wherein all stock and stores are kept under the control of a reliable stockkeeper has been found the only sound working basis for a modern organised factory. Due consideration should be given to the position of the stockroom, which should be central, and chosen with a view to facilitating the handling and transport of material, for the output is influenced thereby. The rooms should be well lighted, well ventilated, and perfectly dry ; wood should be eliminated as much as possible from structure and fittings, and the floors built of concrete. The bins, shelves, and racks should be arranged according to a definite plan for saving time and labour in giving out stores, quite as much as for economising space. Stores which are oftenest called for in combination should lie in close proximity.

To facilitate the accurate and rapid weighing-out or counting of stock and stores, *counting scales* will be found very advantageous in saving time and labour and insuring perfect accuracy. For the purpose of transport, the equipment should include a complete system of trolleys on rails worked preferably by electric power ; if this be impracticable a staff of truckers will be required to propel the trucks through the factory to the proper shop. These trucks may with advantage be supplemented by electric travelling cranes.

Some firms have found it an advantage to deliver most kinds of stock and material to the various departments of the factory in short wooden boxes, in which the parts are kept in that department until used up. Each box is numbered and provided with a tin pocket for the insertion of an identification card which assists materially in tracing the stock in its progress through the factory.

Fig. 1. Box Card for Stock.

Box No. 39. Order No. 679.
Date Rec'd., Sept. 3, 1903. Returned Empty, Sept. 11.
Name of Stock—Bars $\frac{3}{8}$ in. by 1 in. Common Steel.
2 pieces received by Foreman—Williams.
Box empty. Received by Stock-keeper—Philips.

The bins, racks, and shelves should be provided with an indicator, preferably in the form of a dial for registering the disbursements and recording the balance in stock, so that the stockkeeper may be constantly reminded of the state of his stock.

A stockroom should be set apart for finished parts, both those sold separately and those in lots ready for the assembling room.

This completes the equipment for storeskeeping. For recording, a card cabinet is required, which will vary in size according to the requirements of the firm and the amount of recording entrusted to the stockkeeper. Card cabinets have the advantage of being what one might term a flexible equipment which may be increased or diminished in number, drawer by drawer, to suit the needs of the system without interfering with existing records.

THE STORES AND STOCK.

The contents of the Stores or Stock Department, as it is somewhat indiscriminately termed, fall into two distinct classes according to the use to which they are ultimately put ; whether for sale or for use in the factory. The former may be more properly called *Stock* and the latter *Stores*.

Stock consists of finished articles or parts manufactured in the factory.

Stores consist of raw materials, partly finished articles, or parts obtained from outside.

Stores may be productive or non-productive, and are charged accordingly to those departments in the accounts. Productive stores consist of raw material or parts used in the production of stock. Non-productive stores are the supplies charged to manufacturing expense, which are used in factory and office, such as belting, emery wheels, grindstones, files, twist drills, wood bits, planes, knives, buckets, cranks, lubricants, cotton waste, fuel, maps, stationery, etc., necessary for the routine work of factory and office but not directly productive, and of which an inventory must be kept.

THE STAFF.

The staff of the stockroom consists of a thoroughly reliable stockkeeper (with necessary assistants), who has the interests of the firm at heart, is vigilant, systematic, and diligent. If the establishment is on a large scale, and there be no factory or record office, it will be necessary to provide stock clerks to attend to the ledgers and provide data for the cost department. It cannot be too strongly urged that each department should be worked to the full extent of its capacity, and should undertake all that can be accomplished by means of a complete knowledge and experience within its own sphere. There let the limit be drawn. It is unwise to expect of one department what entails knowledge of the current working and day to day conditions of other departments.

Upon the stockroom devolves full responsibility for all the stores and stock from the time they are received until they have been delivered to the shops or to the shipping department, further for the simple or objective clerical work entailed thereby. As the stockkeeper can in no wise compile full records without stepping out of his sphere, it will be found expedient in organising the factory to include a staff for records of all kinds from the data furnished by each department, including the office, of which more will be said in the next section.

The stockroom staff should further include a set of truckers and packers for delivering the stock and stores to the various shops and for collecting the empty cases as soon as they are ready to return. Theirs would also be the duty of fetching finished parts for stock from the last shop, notice being duly given in both cases by the foreman of the department to the stockkeeper. This system will be found to work better than one which entails the handling of stock by the mechanics or workmen of a shop, with the consequent waste of time and the disadvantage of shared responsibility.

A complete sytem of telephones and pneumatic tubes establishing direct communication between the shops, stores, record office, and general office works infinitely better than a staff of messengers, and is more economical and reliable in every way. The installation of pneumatic tubes does not form a large addition to the capital expenditure, and its advantages are incalculable; by its means cards, data, invoices, pamphlets, drawings can be instantly forwarded or obtained without possibility of loss or mis-delivery.

THE RECORDS.

While each of the shops and departments of the works is called upon to furnish data for the records, those from the stockroom are involved in all records, and travel round the factory, forming the nucleus for all additional facts and figures.

Even a small but effective record office is better than a makeshift and division of clerical work; this office undertaking all clerical work usually done in stores and shops, or shipping room, and holding in a firm grasp the threads of all departments, relieves them of clerks, and leaves them free to attend to their own specific duties. Being specially equipped for record work, and having access to all sources of information concerning the business, the record office is prepared to furnish at a moment's notice all data concerning prices, quotations, cost of work, the location and progress of manufacturing and shipping orders; and data concerning the material, plant, equipment, and maintenance.

Although it undertakes all factory accounting, and embodies what is usually the cost-keeping department, the record office does not concern itself with the sales, or the finance of the business; that belongs very properly to the general commercial office. By means of the cost-keeping department, the management is able to cut down the cost of production, the record office cuts down expenses still further by means of a thorough system of supervision and control. Stock tracing forms part of this system of supervision, the importance of which justifies in large concerns the creation of a new post, that of stock-tracer. Upon him devolves the duty of following up every disbursement of stores step by step through the factory's various processes of manufacture, until the finished product leaves the possession of the firm or lies in the warehouse as stock on hand for the filling of urgent orders.

If the record office depended on account books, bound ledgers, and old-fashioned office equipment, the work involved would need a staff beyond all proportion to the usefulness of the office, but by means of the card system of filing, and of loose leaf ledgers, a multiplicity of records is made possible with but little additional labour and that of an inexpensive kind.

(*To be continued.*)

MODERN SLATE QUARRYING.

BY

A. DAWES.

The writer gives a description of a new method of quarrying slate rock which is being adopted at the Rhiwbach Slate Quarry, Blaenau Festiniog.—Ed.

AT all the quarries in the Festiniog district the rock is won by true mining underground, on what is known as the descending method. This system consists of a main incline tunnel running from the top of the slate bed it is intended to work down to the bottom. From this inclined tunnel, long cross tunnels are driven off left and right, which are termed floors. Each of these floors is again apportioned off with "pillars" and "chambers," the average depth of each chamber being about 50 feet, although in some cases they run as high as 80 or 90 feet.

THE UNROOFING PROCESS.

The first operation, when a chamber has been apportioned off, is one termed "unroofing and widening." This consists of removing the rock for a thickness of about 3 ft. to 4 ft. over the whole surface area of the chamber, through and up to the floor above. As this work is done by miners and with high explosives it is entirely unproductive, and is, in fact, a very expensive item in underground quarrying, as, not only does it result in the waste of some hundreds of tons of good rock, through its being broken too small for slatemaking purposes, but this waste has to be cleared and tipped at a cost varying from 6d. (in a few exceptional cases) up to 1s. or more, per ton.

GETTING THE ROCK.

After the miner has completed his "unroofing" operations, the chamber is ready for the "rockman." The work of this individual is to mine the rock and send it, in the form of large blocks, to the surface, where it is taken to the mills, sawn, and dressed into roofing slates ready for the market.

In "getting" the rock the waste is very high, and owing to the depth the rock very often has to fall to the floor when blasted. For every 100 tons of rock sent to the surface for dressing into slates, about 100 ton weight is also sent up in the form of rubbish, which has to be cleared and tipped: in fact, of the total rock removed in the quarry, a proportion of one ton of slates to 14 tons of rock is considered very fair, although in many cases the amount of waste is much higher even than this.

Some idea of the system at present employed will be gained by a reference to plan and section (figs. 1 and 2) which show a vein worked at Rhiwbach by this means.

At this quarry it was decided to develop a part of the estate which had not previously been touched, and with this object, operations were commenced in a bed of slate about 300 ft. to 350 ft. thick, covered with a topping of peat and clay about 30 ft. thick. This bed had been proved by borings some forty years ago, but no attempt had been made to work it.

OPENING UP A QUARRY.

The first operations were commenced in 1898, and consisted of the driving of the usual inclined tunnel, 500 yards long. In order to drain the workings and permanently dispense with pumping operations, a tunnel 842 yards long was continued from the foot of the incline to the foot of the mountain.

With a view to pressing on with the work as speedily as possible, driving was arranged for at both ends, but operations were commenced at the inclined tunnel end with an open cutting through the surface clay for a distance of about 50 yards, and then the tunnelling was commenced, still in the clay.

As the tunnel was advanced it was arched with waste ends from the dressing sheds, and for a time everything proceeded in a satisfactory manner. Owing, however, to the soft and shifting nature of the ground the arching very shortly collapsed.

Timbering was next tried, but without much success, as the timbers were constantly shifting. To overcome this difficulty the tunnel was lined for a short distance with old boiler shells 7ft. 6 in. diameter, which have answered remarkably well, for during the past four years no further difficulty has been experienced with them.

As the work proceeded, the ground became a little firmer, and timbering became possible, until the site of an old well was driven into which caused a deal of trouble and delay. This, however, was overcome in the end, and the work proceeded steadily until the solid rock was reached, when timbering became unnecessary.

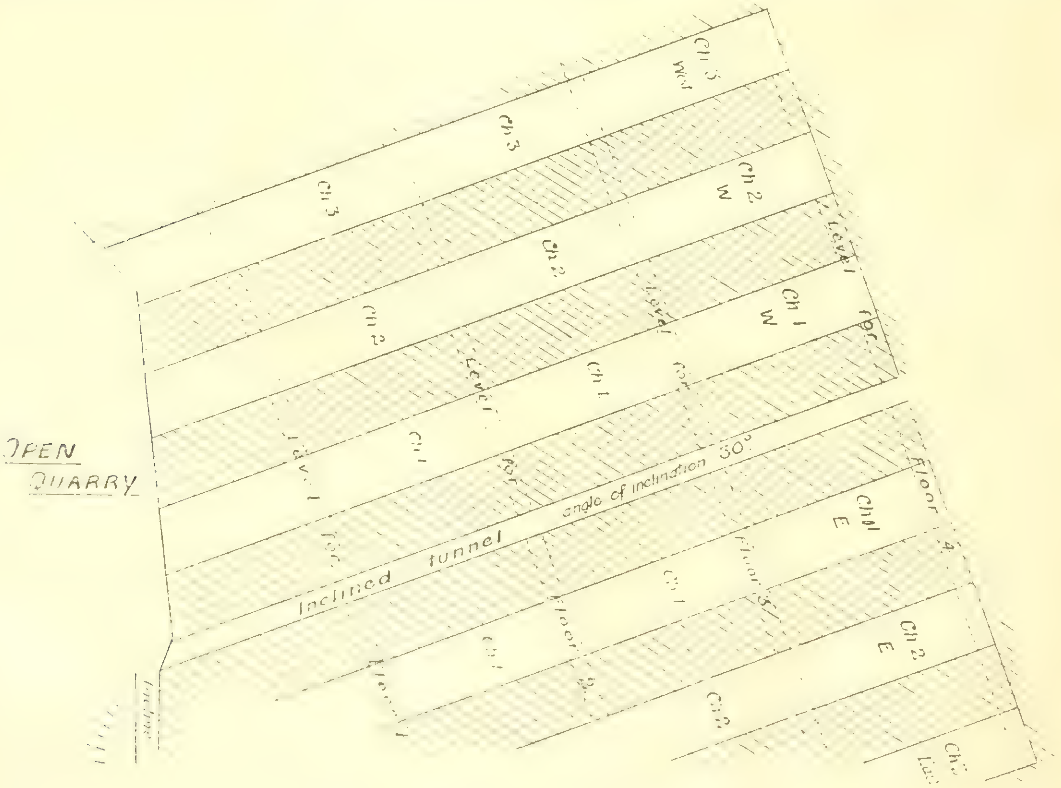


FIG. 1. THE DESCENDING SYSTEM. PLAN.
Scale 1 in. = 50 ft.

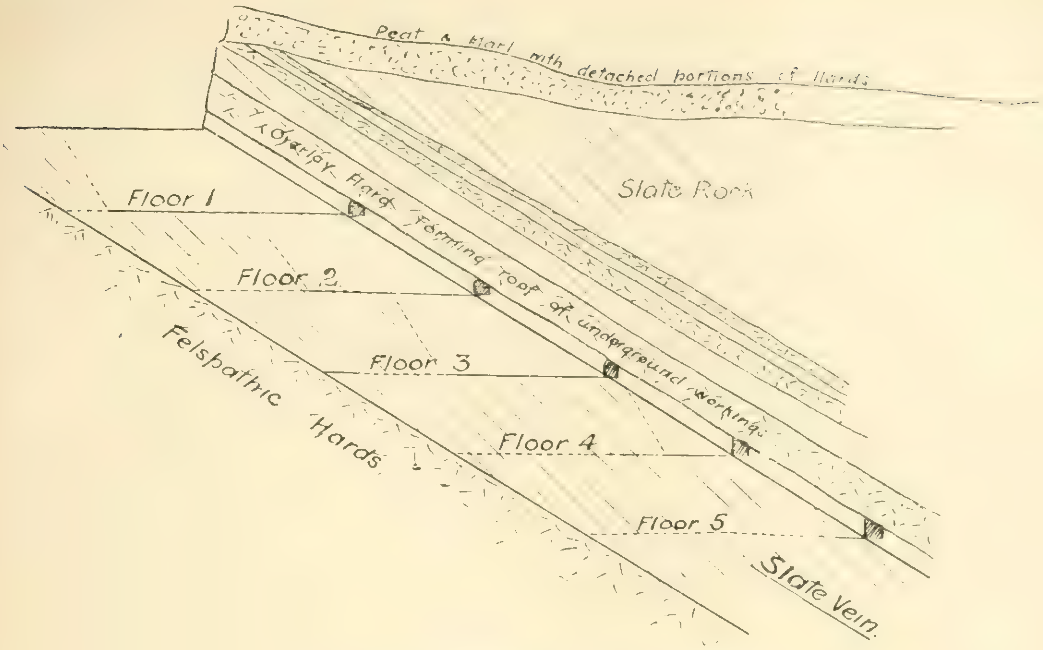

Peat & Marl with detached portions of Hards
Slate Rock
Overlay Hard forming roof of underground workings
Floor 1
Floor 2
Floor 3
Floor 4
Floor 5
Felspathic Hards
Slate Vein

FIG. 2. THE DESCENDING SYSTEM. SECTION.
Scale 1 in. = 100 ft.

Water had all along caused a deal of trouble, and to clear it pulsometers were used, which were hung in chains and provided with steam from a small vertical boiler on the surface. These worked very well, and efficiently handled the dirty water and mud.

The level had been commenced at the other end, but as this was all through solid rock, no difficulty was experienced, the water all finding its way out without mechanical assistance. As hand work did not proceed at a very rapid rate an air compressor was erected at the quarry, and the work was thenceforward carried on with the aid of rock drills; air at 70 lb. pressure being conveyed over the mountain to the forebreast in a line of 2-in. tubes, nearly a mile and a half in length. The rate of driving in the level was five to six yards per week.

At the inclined tunnel end serious difficulty was caused by the water, and as the forebreast had now got far from the surface a double ram pump, by Pearn, of Manchester, was put in and driven with the compressed air. The exhaust air from the cylinders was turned on to the forebreast, and very speedily cleared the place of smoke after firing. The pump was constantly moved forward as the work advanced.

The levels and gradients were carefully watched, and when the level was completed, driving up was commenced to meet the men who were going down.

When both ends met there was not the slightest difference in level between them.

COST OF THE WORK, Etc.

The costs for driving were as follows:—

For the Level.

	Cost per yard.		
Wages and explosives... ...	£2	14	7
Enginemen	[illegible]	6	0
Coal, oil and engine stores	0	10	11
Surveying	[illegible]	1	2
Sundries	[illegible]	[illegible]	7
Giving a total cost per yard of ...	£3	13	3

For the Inclined Tunnel.

Wages and explosives	£3	1	6
Enginemen, coal, oil, engine stores, surveying and sundries ...	0	18	8
Or a total cost per yard of ..	£4	0	2

The total amount of slate rock opened out by this inclined tunnel and level is [illegible]

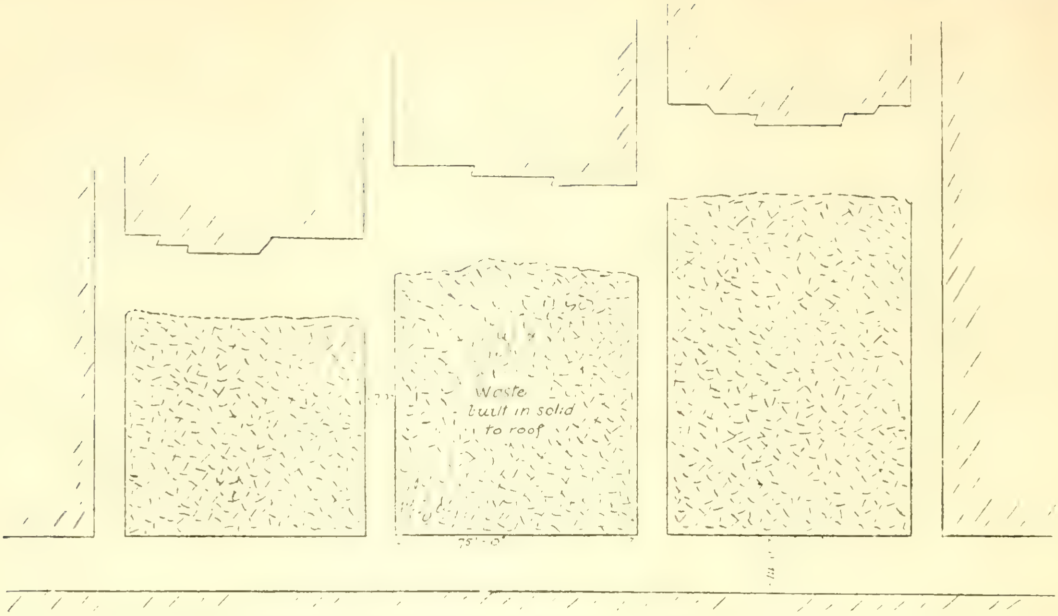


FIG. 3. THE ASCENDING SYSTEM. PLAN.

tons. Of this, 16,000,000 tons are capable of producing slates of the finest quality, while 12,000,000 tons will give slates of a fair quality, the remaining 12,000,000 tons being of an inferior nature and not worth working.

SCHEME FOR WORKING THE LEVEL.

In opening out a quarry on the present system, the rock for the full length of the level could not be touched, and would have to be left unworked, as operations would be limited to the ground opened out by the inclined tunnel, the level being merely used for drainage purposes.

With a view to finding some satisfactory method of working the rock traversed by the level, Mr. H. Humphris, of Blaenau Festiniog (who has the management of the place), made some very extensive investigations into the methods employed at home, in America, and on the continent, and being most favourably impressed by the system employed at some of the largest quarries in France, he visited them and studied their workings on the spot. The system now about to be described is the one planned by him as being most suited to the requirements at Rhiwbach and is so designed that all the rock available and worth working, can be procured, and at a cost much below that incurred by employing the ordinary or present system.

THE ASCENDING METHOD.

In the system planned out by Mr. Humphris, the first work necessary is to drive small cross

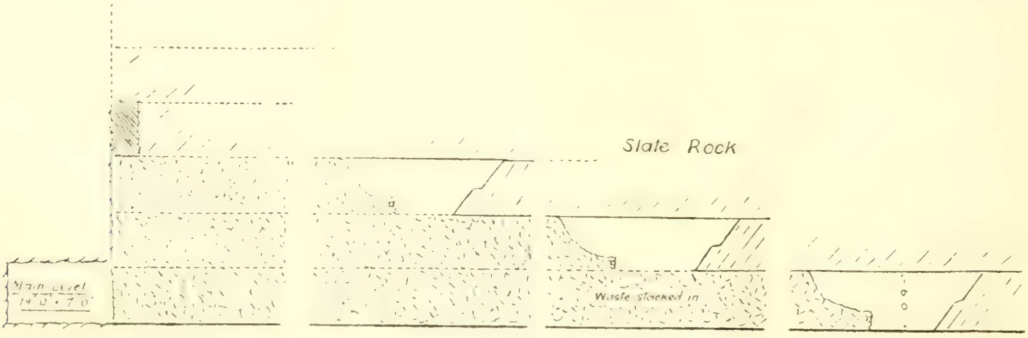


FIG. 4. THE ASCENDING SYSTEM. SECTION.

levels, 4 ft. wide and 8 ft. high, at an angle of 90° to the main level. These levels are continued on to the opposite boundary of the property. As soon as two of them have attained a length of 25 to 30 yards the rock between is cut along the bottom with the wire saw, and after this has been done for a sufficient distance the top is also cut, at a height of 6 ft. above the lower or "floor" cut. The piece set free is then handed over to the rockmen, who are thus enabled, without the aid of any explosives, to slice it off, rough-dress it underground, and send it up to the surface ready for sawing and splitting. The rubbish and waste produced in driving the levels and splitting up the rock, instead of being cleared, pulled out and tipped, is built or stacked in by the men working the rock, up to the level of the roof in order to form the floor of the next higher gallery. In stacking this waste from the first, or bottom gallery, the face of the latter is kept back for about 3 yards, so that the main level, originally 2 yards wide, is made 5 yards wide, allowing room for a double road to be put in.

The method of working will be better and more clearly understood by a reference to the plan and section, figs. 3 and 4.

The following are the advantages claimed for this mode of working.

Under the old conditions the amount of rock available would have been 17,500,000 tons. Of this 8,000,000 tons would have to be left in as "pillars." Of the remaining 9,500,000 tons, 250,000 tons would be wasted in unroofing and other preparatory work; 4,250,000 tons would be further reduced to waste in getting the rock for slatemaking purposes, and the remaining 5,000,000 tons would be sent to the mills for slatemaking purposes, resulting in 1,500,000 tons of dressed slates, ready for the market, and 3,500,000 tons to be cleared from the mills as waste and tipped.

With the new system the amount of rock available is 40,000,000 tons. Of this amount 100,000 tons will be wasted in cutting the small levels or "free sides," leaving 39,900,000 tons for slatemaking purposes. Of this amount 14,000,000 tons will be sent to the surface in a rough dressed state, ready for sawing and splitting, resulting in about 7,000,000 tons of dressed slates.

On this system the waste in "getting" the blocks is considerably less than in the old, but as the blocks are rough-dressed under ground before being sent to the surface, the total amount of waste left behind and built in, is about equal to the amount cleared in the old system. The waste in the dressing sheds, however, is considerably less, the waste in unroofing in the old system is also saved, and the amount left in as pillars is altogether done away with. Even if pillars were found to be necessary they would be at least one half the thickness of those at present employed.

In some quarries worked on the present system the amount of waste in unproductive work is equal to $\frac{1}{15}$th to $\frac{1}{20}$th of the total contents of a chamber. In the Labassere Quarries situated in the Pyrenees, which are worked on a system somewhat similar to the one here described, this waste is as low as $\frac{1}{80}$th the total contents. In the present case the total amount of rock gained and saved will be equal to 20,000,000 tons, which equals an increase o 5,000,000 tons of dressed slates in the tota production of the quarry. While, if the workings were limited to the area which could be worked by the old system, the adoption of the system herein described would result in an increased profit of nearly 50 per cent.

In nearly all quarries a great saving would be effected by the more general use of the wire saw, but the ascending method cannot very well be adopted except in new ground or in quarries just commencing to open out.

In conclusion, the writer has to acknowledge his indebtedness to Mr. H. Humphreys for the information placed at his disposal and for permission to copy the drawings with which this article is illustrated.

THE INSTITUTION OF MINING ENGINEERS.

GENERAL MEETING IN LONDON.

THE thirty-eighth general meeting of the Institution of Mining Engineers opened on July 2nd, at the rooms of the Royal Geological Society, Burlington House, and was continued on the two following days. Sir Lindsay Wood, Bart. (President), occupied the chair, and among those present were Messrs. A. S. E. Ackermann, F. R. Atkinson, J. W. Atkinson, W. E. Bainbridge, N. Atkinson, J. Barrowman, G. Bradford, B. H. Brough, J. C. Cadman, W. Charlton, E. B. Clark, W. F. Clark, E. B. Clarke, A. C. Cormack, J. Daglish, J. Etherington, G. J. Findlay, F. F. Forsyth, T. E. Forster, C. Le Neve Foster, G. Foster, M. Fryar, W. E. Garforth, J. Gerrard, R. Guthrie, H. Hall, W. Hargreaves, E. W. Hawker, F. W. Hard, J. Heath, H. R. Hewitt, I. Hodges, J. J. Hopper, J. E. Hodgkin, J. A. Hood, H. Hall, F. W. Hurd, J. S. Jeans, C. C. Leach, J. W. R. Lee, G. A. Lewis, R. H. Longbotham, G. May, D. MacGregor, A. D. Mitton, T. W. H. Mitchell, A. McLaren, J. Morris, H. B. Nash, J. Nevin, M. Nicholson, W. H. Pickering, H. C. Peake, R. H. Robinson, G. C. Robinson, A. Smith, H. S. Smith, H. Stevenson, G. R. Thompson, H. J. Thomas, S. L. Thacker, M. W. Waterhouse, O. Walmesley, J. F. West, W. S. Wilson, R. Winstanley, T. T. Wynne.

NEWCASTLE OR LONDON?

In reply to Mr. J. S. Jeans, the President announced that the council considered it was not advisable to have the headquarters of the Institution removed to London at present.

LUXEMBURG AND ITS IRON-ORE DEPOSITS.

THE first paper submitted was by Mr. S. Walter Pearse, and dealt with Luxemburg and its Iron-Ore Deposits. The following is an abstract :—

The railway-system of Luxemburg, fostered by iron-mining, both directly and indirectly, is more extensive in proportion to area and population than that of any other country. It possesses a thermal spring more highly mineralised than any in Europe. Its iron-ore, richer and more easily mined than that in neighbouring countries, is also more readily smelted owing to the intimate admixture of lime, so that with a suitable mixture of the charge no extraneous flux is required, while its mining laws differ from those of any other country.

The iron-ore deposits occur in the lower districts of the country, extending along the western half of the southern frontier, being overlain by a slight alluvial cover. The iron-ore, stratified as in Cleveland, is a ferruginous oolite, or limonite, known as *minette*, and forms the small but very important northern portion of the great iron-field which extends southward a little beyond Nancy, with a width of about 62 miles (100 kilometers), the eastern and western boundaries being generally parallel with the Moselle and Meuse respectively, while the seams dip slightly to the south-west.

The method of working, almost invariably the same, varies only with the nature of the ground. Trenches are cut in the hill-side so as to lay bare the rock below, descending parallel with one another from ridge to base in the case of a crest, but radiating from apex to periphery in an isolated hill. The surface-soil, between the trenches, is then turned over downward on to the hill-side, thus forming a series of terraces suitable for cultivation. The ore cropping to the surface is then taken out, the sterile rock being stacked to serve for packing future mine-workings. The same method is continued, until a depth of about 65½ feet (20 metres) from the original surface is attained, below which open cast-working would become too expensive. Mining by adits and drifts is then resorted to, the roof being allowed to fall when there is not sufficient material for packing.

The general practice is to break up the ore, first by men with sledges and afterwards by boys with smaller hammers, but in some cases by stone-breakers. In this manner, the calcareous concretions can be readily separated, and a more uniform furnace-charge obtained. At some of the larger blast-furnaces, the experiment was tried of charging in the ore as it is mined, when it was found that the coke-consumption did not materially increase ; but, at some older and smaller furnaces owned by the same company, this experiment was followed by a decided increase in the coke-consumption.

The first furnace was built of ashlar stone, 44 feet (13·5 metres) high, at La Sauvage on the French frontier, about 1790 ; and another, adjoining it, of rubble-masonry, about 49 feet (15 metres) high, was worked so late as 1880. The early furnaces were erected to smelt the alluvial ore in their neighbourhood by means of charcoal ; and it so happens that there are still two sets of furnaces, far removed from the limonite, that are still working. These furnaces, and also those erected on the great body of ore, turn out an increasing proportion of basic pig every year ; and steel-works have been added to three of the ironworks for converting the pig-iron into steel by the Thomas-Gilchrist process.

Last year, owing to the depression in trade, the production of iron-ore diminished by nearly one-third; and the 75 mines only yielded 4,455,179 tons, against 6,171,229 tons in 1900. With an ore-consumption of 2,878,150 tons, 2,771 workpeople, and 25 furnaces in blast, pig-iron was produced to the amount of 916,404 tons (against 970,885 tons in 1900), comprising 111,593 tons of forge, 132,438 tons of foundry, 672,075 tons of basic, and 297 tons of transition-pig; and with 426,376 tons of pig-iron the three steelworks turned out 257,055 tons of ingots, blooms, slabs, billets and finished steel, against 184,714 tons in 1900.

The paper was discussed by Messrs. Oswald Walmesley, Bennett H. Brough, and J. S. Jeans.

THE MINERAL RESOURCES OF THE STATE OF RIO GRANDE DO SUL, BRAZIL.

MR. H. KILBURN SCOTT contributed a paper on the above subject, but was unavoidably absent. The paper was therefore read by Mr. Walton Brown (secretary). In the course of the paper, the following facts were mentioned :—

The principal known gold-deposits of the Rio Grande occur in the vicinity of the village of Lavras, which is situate 37 miles (60 kilometres) north from Bagé and about 800 ft. (250 metres) above sea level.

The gold occurs principally in the syenite rock, in small stringers of quartz and impregnations (stockwerks), the enclosing rock on each side of them. The syenite, at its contact with the quartz-stringers, seems to be decomposed to a varying thickness, which amounts in some places to 6 ft. (2 metres) or more, the quartz having disappeared presumably as a result of the action of the solution carrying the gold, etc. The mineralization is irregular, and generally limited in area, the rock being found to be very rich in places, but often pockety.

Galena, iron pyrites and zinc-blende occur associated with the gold, the former being considered a good guide for auriferous ground, although as a matter of fact no rule can be established as non-auriferous galena is common.

Ordinary iron pyrites is often very rich in gold, and parcels of pyrites, weighing a few tons, were shipped to England for reduction in the early stages of the exploration, containing from 500 grammes to 700 grammes of gold per ton.

Speaking generally, it must be confessed that, up to the present time, the working of the different auriferous deposits in the State of Rio Grande, has not been particularly successful, the difficulty being the small size of the quartz-veins and the irregularity of their gold contents, owing to their pockety tendency. Mining operations are being continued by the several companies, and it is anticipated that results as good as those shown in Uruguay will be obtained before long.

The principal copper-deposit as yet known, namely, that of Camaquam, is about 50 miles (80 kilometres) from the Rio Negro station of the Southern Brazilian railway and 2 miles (3 kilometres) from the Camaquam river.

The zone in which mining is expected to be most profitable is 1,600 ft. by 2,600 ft. (500 metres by 800 metres) and the average height above the lower adit is 250 ft. to 300 ft. (80 metres to 90 metres). The average thickness of the lodes worked during 2½ years has been 4 ft. (1·25 metres) and the ore assayed 6½ per cent. of metallic copper, with about 19 pennyweight (30 grammes) of gold per ton.

The cars of mineral coming out of the mine are tumbled over a grizzly and perforated plate with 1 in. (25 millimetres) mesh. The mineral is sprayed with water and sorted by hand, the picked rich ore essaying 30 per cent. of copper. The barren rock is thrown away, and the remainder, which averages only 7 per cent. of copper, is dressed in a small concentrating plant, with breaker, roll-mill, trommells, hand-jigs and round-buddles. The resulting concentrate averages 28 per cent. of copper.

The two principal coal-deposits are known as Santo Jeronymo and Candiota, the first situated to the north-east and the other to the south-west of the Serra do Herval.

The Santo Jeronymo deposit lies about 11 miles (18 kilometres) from the Jacuhy river with which it is connected by a metre-gauge railway. The coal-seam is 6½ ft. (2 metres) thick and is mined by the pillar-and-stall method, the conditions for successful and economical mining being most favourable. The roof is good, and the quantity of water in the mine very small. The coal is of a semi-bituminous and schistose character, and must be carefully picked in order to get good results. Analyses prove that the mineral is not satisfactory as a gas-coal. The output of the mines has averaged between 10,000 and 20,000 tons during the last few years, and the greater part has been used by the Uruguayan railway and native coasting steamers. Owing to the high percentage of ash in the coal, specially wide grate-bars must be fitted to the boiler-furnaces in which it is used.

The carboniferous formation in the valley of the Rivers Candiota and Jaquarao is very extensive, being about 54 miles (90 kilometres) long by 31 miles (50 kilometres) wide. Many attempts have been made during the last century to work these deposits; and, as far back as [illegible], a concession was given by the Imperial Government for the construction of a railway to connect the deposits with a port.

The coal occurs in a bed about 7 ft. thick, resting on mica-schists and overlaid by a ferruginous sandstone, and it has an inclination of about 10 deg. towards the south-west. The outcrop being very extensive along the sides of the valleys, the conditions for economical working are even better than at Santo Jeronymo. The bed of coal consists of thin alternating layers of almost infinitesimal thickness of carbonaceous and argillaceous matter. Owing to this peculiar structure and the swelling of the argillaceous matter on exposure, the mineral will not bear transport or storage.

The analyses show that the quality of the mineral is better than that of Santo Jeronymo, but the grave objection of its friability on exposure causes it to have little commercial value. Some of the mineral has been used from time to time for the electric-light plant at Bagé, but the results have not been satisfactory.

Wolfram has been found near Encruzihado in a vertical quartz-vein, in the granite-rock, which could be traced for some distance. Agate is found, in quantity, at Uranguayana, near the boundary between the republic of Uraguay and the state of Rio Grande. Originally, the industry was very prosperous, but latterly it has been in a decadent condition owing to the unremunerative prices ruling for the mineral.

So little exploration has been carried out and so exceptionally favourable are both the physical and economical conditions for successful mining in the Rio Grande, that there is every possibility of a great increase in mining work in the future.

ELECTRICAL PLANT FAILURES: THEIR ORIGIN AND PREVENTION.

A USEFUL paper read by Mr. Campbell Cormack gave an analysis of breakdowns in continuous current dynamos and motors, the observations ranging over a period of about four years. These breakdowns were dealt with in a most systematic manner, the accompanying tables giving (1) a description of the nature of the accidents; (2) the point of origin of each breakdown; and (3) an analysis of the causes of the breakdowns.

It was emphasised that the only safe way to avoid disaster is found in installing suitable first class electrical machinery of ample rating, and looking after it well.

The following is an abstract :—

The writer does not wish to give the idea that all dynamos and electric motors are liable to an excessive number of breakdowns in comparison with the breakdowns met with in non-electric machines. Unfortunately, a large number of bad and unsuitable plants have been installed in this country, and the results met with in such plants have in many cases been looked upon as inseparable from and characteristic of all electric plants, but such judgment is inaccurate and unfair. With reasonable care in design, manufacture, and working, electric machinery can be, and has been, made more reliable than steam, gas, or oil-power plants. This remark should be kept in view when dealing for a time with a somewhat blacker aspect of the case.

The root of every electrical undertaking is financial, and financial considerations rightly rank first in the arrangement of any such scheme. The problem to be solved in every case is how to attain satisfactorily the desired end in the cheapest possible manner. This involves a careful balancing of capital-expenditure, standing charges (interest, depreciation and sinking fund) and running charges, including employers' liability, the latter being the financial aspect of safety.

A doctrine now much preached in relation to machinery is that of the merry and short life, or high rating. Probed to the bottom this only means low capital expenditure and high up-keep charges.

Having decided to obtain high-class plant of the type suited to the requirements, the next step is to see that this is obtained. The percentage of breakdowns attributed to defective design and workmanship show how important it is to make sure that the article supplied is actually first-class; very often the only condition attached to the supply of the dynamos and motors is that they shall drive a given load. Occasionally high efficiency is specified and obtained, but the user of electrical plant requires more than this. He ought to ensure as far as possible that the plant would be likely to continue the satisfactory performance of its duties. Unfortunately, there is no simple test or set of tests that can ensure this. A satisfactory temperature-test helps. An insulation resistance-test is of little service. A guarantee of twelve months, while being useful, does not ensure continued satisfaction, as it is often only at the expiry of this period that many defects in design, particularly in relation to insulation appear.

The only way to obtain reasonable expectations of the continued satisfactory working of the machine is to combine a careful examination with the above-mentioned tests. This examination should show whether, in the light of past experience, the proportions and arrangement of parts and the selection of materials are such as could be expected to give satisfactory results. Unfortunately, this cannot always be ascertained by examination of finished machinery. There are also many defects in workmanship which may not be discovered after the completion of the machinery. The safest course appears to be as follows :—First obtaining suitable, satisfactory guarantees of efficiency, output, freedom from sparking, and of general satisfactory working; then the detailed design of the machine should be gone over on the plans to see that all points are satisfactory; and afterwards the machine should be examined at several stages in the course of manufacture, to ensure, as far as possible, that the workmanship is satisfactory.

Having obtained suitable machinery, it is necessary for the attainment of the desired end that it should be well treated. In installing, every possible precaution should be taken to guard against the two great enemies, damp and dust. Afterwards, in working, it should be kept free from damp, dust, and, except in the bearings, oil. Where enclosed motors are used, these ought to be taken apart for thorough cleaning, at least once a year, and oftener if possible.

It must not be assumed that this implies that electrical machinery requires careful nursing and highly skilled attention. With machinery of the character here advocated, this is far from being the case. In almost all but very complicated plants, all that is required is the periodical cleaning, lubrication, and attention to the simple adjustments of brushes, etc., with due observations of a few simple precautions in starting and stopping.

PNEUMATIC AND ELECTRIC LOCOMOTIVES IN AND ABOUT COAL MINES.

A PAPER, which evoked much interest, was read on the above subject by Mr. A. S. E. Ackermann, A.M.Inst.C.E., A.C.G.I. The author last year made a tour extending over 5,000 miles, and lasting four months, in the United States, chiefly for the purpose of reporting on American mechanical methods of coal mining, and the paper summed up his varied observations.

An allusion was first made to the differing conditions at home and in America. Briefly, it may be stated that the seams which are being worked in America are much thicker and nearer the surface than they are in Britain, the dip is very much less, 5 per cent, being about the maximum, while faults are almost unknown. The roofs are usually good, fire-damp is rare, and a large percentage of the mines are drift ones. This latter fact is perhaps the most important of all in connection with pneumatic and electric haulage as practised in the United States, for the electric haulage there is not the least like that which is in use in this country. Here, the electrical energy is transmitted to the pit bottom, where it is used for driving one of the rope-haulage systems, but in America all the cases that the author saw (he inspected twenty-one coal-mines) were on the over head-trolley system, very similar in fact to most of the electric trams in this country, though the locomotive is quite distinct from the tubs, that is, the system is not that known as the multiple unit.

THE PNEUMATIC SYSTEM.

Similarly, the pneumatic system uses a single locomotive. Pneumatic locomotives are much more cumbersome than electric locomotives, owing to the two large steel compressed-air vessels which they carry, and hence they can only be used on the main haulage lines and where there are no sharp curves. These storage cylinders are in the case of a 13-ton locomotive, 2 ft. 9 in. in diameter, 16 ft. long, with a capacity of about 160 cubic feet each. Occasionally, there is a tender to the locomotive carrying three more such storage cylinders, so as to increase the distance the locomotive can travel without having to recharge.

For a 13-ton locomotive, makers recommend that the radius of the sharpest curve should not be less than 35 ft., and state that the least radius practicable for it is 20 ft. In one mine visited all curves had a 54-ft. radius.

The air-storage vessels are charged with air at a pressure of 700 lb. to 1,000 lb. per square inch, but this is reduced to about 140 lb. before it enters the cylinders.

With regard to the comparative cost of the plant for pneumatic and electric haulage, Mr. A. de Gennes stated that the cost of an electric installation is only one quarter that of a pneumatic plant, though the author does not think the difference can be quite as much as this. The same authority states that a rope-haulage costs in the first instance three times as much as an electric trolley one.

As to the pressure of the current, 250 and 500 volts were the only pressures met with, and all were direct current, though in one mine three-phase current was used for working the pumps. It looks probable that three-phase current will be much more used in mines in the future, for there are no commutators used with the system, and consequently one of the chief sources of sparking is absent. On the other hand, it is more dangerous.

Of the mines visited which used electric haulage, seven used a pressure of 250 volts, and five used 500 volts. Sparking between the trolley wire and the collector is of course common with either pressure. As to the danger of 500 volts, Mr. A. P. Trotter, the chief electrical engineer to the Board of Trade, has recently given a number of impressive and conclusive demonstrations of the great exaggeration there is in this connection. When one is new to the experience of going about a mine with bare conductors, fixed to the roof, about five feet off the ground, the feelings are not perhaps of the pleasantest, but when lying full length on top of an electric locomotive, whisking along a comparatively rough track at eight or ten miles an hour, you have to keep your head flat down to keep it out of the way of the conductor immediately above it, then it becomes exhilarating. The authorities at the mines were not very communicative on the subject of electrical accidents, but the general opinion seemed to be that if a man's heart is sound then a 500 volts shock does not have much more effect than unnerving him for a couple of hours.

The tendency in America is undoubtedly to use electric locomotives and coal-cutters more and more. Of the mines visited, twelve used electric locomotives and four pneumatic locomotives while a fifth was changing from rope to pneumatic haulage, and the remaining four had rope or mule haulage.

Replying to various points raised in the discussion, Mr. Ackermann admitted that it was very difficult to obtain reliable figures with regard to the comparative cost of locomotive and rope railways. The dangers in American mines would easily afford scope for a separate paper. It was a fact that in those mines in which they cut less coal by machinery, up went the death-rate. All the mines he visited had a double track, *i.e.*, a line in and a line out. He saw no three-phase locomotives at work. The lines did not have a large number of curves. He did not notice breakages of pipes; on the contrary these seemed to be in a remarkably good condition. He agreed that in the matter of care for life and limb the Americans were not quite so black as they were painted, but quoted some amusing instances showing the freedom which obtains in America for receiving gratuitous shocks.

THE ELECTRICAL DRIVING OF WINDING GEARS.

IN this paper the writer, Mr. F. Hird, set forth the advantages and merits of the application of electricity to winding gears, urging that it has now been sufficiently developed to be considered within the range of practical possibilities for mines and collieries in this country.

He remarked that the chief problem for the electrician lies in finding the most suitable method of control. The motor itself is a well-tried machine and presents no difficulty, but the controlling apparatus must be designed to meet the arduous conditions of frequent starting and stopping, must provide the greatest accuracy of control and must permit of steady running at slow speeds for the purpose of repairs, inspection, etc., in the shaft.

The writer described at length the Siemens-Ilgner system, claiming that it unites in the simplest and most practical way yet suggested the advantages of power-storage and the consequent equalisation of the load on the generating-station, the absence of rheostatic losses, and the most perfect speed-control. Mr. Ilgner, chief engineer of the Donnersmarkhütte, should be credited with the suggestion of providing for the necessary storage of energy by a suitable high-speed fly-wheel. The combination of this fly-wheel with a motor-generator, which furnishes the means of control, constituting the essential feature of the Siemens-Ilgner system.

MINERS' ANÆMIA, OR ANKYLOSTOMIASIS.

THE writer of this paper, Dr. J. S. Haldane, F.R.S., was asked a few months ago by the Home Secretary to make an inquiry, in conjunction with Mr. J. S. Martin, H.M. Inspector of Mines, into the health of Cornish miners.

One of the first results of this inquiry (in which Dr. A. E. Boycott, and later Dr. S. G. Scott [illegible]) was to show that an illness which affected the miners at Dolcoath and other mines in the Camborne district of Cornwall, was the tropical disease known to medical men as ankylostomiasis. [illegible] may easily spread in other [illegible] mines, the disease and its manner of communication are well worth the attention of mining engineers.

The main symptoms are : (1) Pallor, best seen on the inside of the lips and eyelids ; and (2) palpitations and great shortness of breath on any exertion. In well-marked cases, the man affected is unable to work ; and, in severe cases, the weakness is so extreme that death may result in the absence of suitable treatment. Besides the pallor, palpitations and shortness of breath, there is often, though not always, a good deal of pain or discomfort in the stomach, and a capricious appetite. The Cornish epidemic has been accompanied by the prevalence among the miners of well-marked skin affections.

It is not possible to discover, now, the original source of the Cornish epidemic, but it is evident that the Cornish mines are particularly exposed to infection, as Cornish miners are constantly going to and coming from metalliferous mines in tropical countries all over the world. The infection may easily have been brought from West Africa, or Brazil, or Mysore, or Kimberley, or various other places where ankylostomiasis exists. Infection from any European source seems much less probable.

One of the symptoms is general want of energy, disinclination for work, and depression. In the course of the paper it was shown that the worm, which is the cause of the disease, can easily be expelled when its presence is recognised. Unfortunately, the disease has obtained a firm hold in Cornish mines, which will thus certainly continue for some time to be a possible source of infection to the British collieries.

Sanitary precautions in the mines, with the intelligent co-operation of the men, were shewn to be necessary to the prevention of the spread of ankylostomiasis.

OTHER PAPERS.

The remaining papers prepared for this meeting were :—

"The Lake Superior Iron-ore Region." By Prof. Van Hise

"Electric Coal-cutting. By Mr. W. E. Walker.

"Further Remarks on the Portuguese Manica Goldfield." By Mr. A. R. Sawyer.

"Coal-fields of the Faröe Islands." By Mr. G. A. Greener.

"Water-softening Plant." By Mr. Vincent Corbett.

"The Redevelopment of the Slate-trade in Ireland." By Mr. G. H. Kinahan, M.R.I.A., District Surveyor Retired), Geological Survey of Ireland.

"The Smelters of British Columbia." By Mr. W. Denham Verschoyle.

"The Common-sense Doctrine of Furnace-draught." By Mr. H. W. Halbaum.

"The Ventilation of Deep Mines." By Mr. Arthur C. Murray.

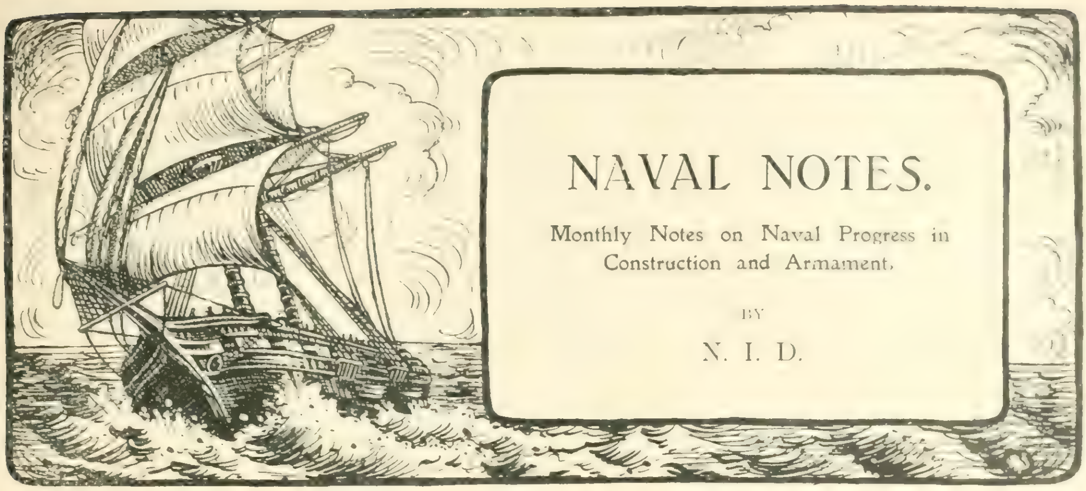
The meeting closed with a vote of thanks to Sir Lindsay Wood, who was complimented upon the able manner in which he had filled the chair.

THE ANNUAL DINNER.

The annual dinner was held at the Holborn Restaurant, Sir Lindsay Wood, Bart. (President) in the chair. The usual loyal toasts were proposed by the Chairman. Professor Bauermann, in proposing "The Institution of Mining Engineers," remarked that, although he had drifted off in other directions, and could not claim to be an active member of the Institution, he fully realised the excellent work it was doing, and heartily congratulated them upon it. He commented upon the high standard of interest attained by the papers, including that by Professor Van Hise, on the Lake Superior region. He almost began his career at Lake Superior. He had the good fortune to be out there in, he believed, 1864, and had followed the development of the Lake Superior region from that time to this. The toast of the visitors was proposed by Mr. Teale, who expressed satisfaction at seeing so many distinguished electrical engineers present. The toast of "His Majesty's Inspectors of Mines" was given by Mr. Robinson, who referred more particularly to the excellent services of Mr. Hall, and the confidence placed in him by colliery owners. He congratulated him upon the fact that His Majesty the King had conferred upon him the Imperial Service Order, a well-merited honour. The other toasts were "The Chairman" and "The Secretary."

EXCURSIONS.

Arrangements were made for members to visit the Colliery Exhibition at the Royal Agricultural Hall, the Electric Power Station of the County of London, the Works of the Brush Provincial Electric Lighting Company, Ltd., at Clerkenwell ; the Central Power Station of the London United Electric Tramways at Chiswick, and the National Physical Laboratory at Teddington.



NAVAL NOTES.

Monthly Notes on Naval Progress in Construction and Armament.

BY

N. I. D.

PARTICULARLY interesting in connection with the articles which have appeared in this magazine on Portsmouth Dockyard is the report of Mr. Austin Chamberlain's Committee on the Berthing Accommodation of the Public Establishments, and the Naval Works Bill, in which effect is given to the recommendations of that Committee. The congestion at our dockyards is not a thing of yesterday. As the fleet grew in numbers, and as ships grew in length, so it became necessary to extend the dockyards and to enlarge or build new docks. Moreover, in other respects there has been a growing need for augmented and improved berthing facilities at the naval ports at home and abroad. Indirectly, if not directly, the torpedo and the torpedo-boat were responsible in a measure for some of these improvements in harbourage. The roads at Portland now enclosed, and the new breakwater being built at Malta, are examples of this effect of the torpedo. But more than anything of the kind it may be said that the augmentation of the fleet at the time of the Naval Defence Act, was the immediate cause of congestion in the yards.

Those who have visited the public establishments recently cannot fail to have been struck by the large number of vessels lying in the basins in reserve. They are packed close together, and occupy a very large space. Nor does it appear that the extensions which have been made from time to time, at Portsmouth, Chatham, and at Keyham in the Western Port, have been sufficient to meet the demands for increased accommodation. Just three years ago the Admiralty appointed a committee to deal with the matter, and the following points were noted for their consideration and examination :—

(*a*) Present and (*b*) prospective accommodation for ships in His Majesty's dockyards, and how the harbours and other anchorage waters at our disposal can be utilised for ships both completed and under construction, for which berthing will be required in the immediate future ; (*c*) accommodation for older ships, whether it is to be found in the dockyard ports or elsewhere, in any suitable place where berthing may be available ; (*d*) additional dredging required ; (*e*) number and description of moorings and material required, both at home and for Malta and Gibraltar ; (*f*) the quantity of chain which is likely to be obtainable from the trade within a year, if orders be placed to the full producing power of the country.

Several changes have taken place in the constitution of the committee since it was first convened, but the report and recommendations have been unanimously approved. In an interim report the committee made suggestions for the improvement of the four principal ports, where they satisfied themselves that relief was urgently required. These suggestions are in process of being carried out, and in the Naval Works Bill of last year funds were taken for the purpose. In the main the suggestions referred to dredging, for the purpose of widening the area in which accommodation could be given. But they also included improvements and alterations in connection with the basins and docks. Nevertheless, the committee noted at the same time that even when their recommendations have been given effect to, there will still be a want of facilities at the ports. They have therefore to look around for this additional accommodation

The next result of the work of the committee was the announcement that a new naval base was to be provided in the Firth of Forth. The process by which the Admiralty, with the assistance of the committee, arrived at this decision is described in the report. First of all facilities for accommodation were looked for in such harbours as Southampton Water, Portland, Milford Haven, Tilbury Dock, [illegible] Harbour, Falmouth, and certain ports in Scotland and Ireland. But in none of these were the committee able to get what they wanted.

They reported, therefore, that as the growth of the navy will shortly make it impossible for the naval ports to accommodate all the ships, they felt that the time had come for the Admiralty and the country to consider seriously whether the formation of another naval establishment had not become necessary.

In the Naval Works Bill a sum of £200,000 is taken for the new naval establishment at Rosyth, as it is to be called, the harbour in front of the establishment being known as St. Margaret's Hope. Money is also taken for the extension of the dockyards, for works on the enclosure and defence of harbours at Gibraltar, Portland, Dover and elsewhere, also for coaling facilities and fuel storage at several of the dockyards, and for building naval barracks. In addition to these important matters it is intended to light by electricity all the naval establishments of the country. It is somewhat astonishing that such a thing has not been done before. When it is remembered that in the event of war these establishments would be working day and night, it is surprising that the lighting facilities should have so long remained what they are. Doubtless the matter has been considered by past Boards of Admiralty, and it has been felt that more pressing needs required to be dealt with first, but it will always be remembered, as among the many great reforms initiated by Lord Selborne's colleagues, that he and they lighted the dockyards with electricity, making it possible to continue work in them when night is made into day. No other matter of quite equal importance is dealt with in the Naval Works Bill. But there are to be new torpedo ranges—a long-felt want. And in connection with the re-organisation of the coast-guard some expenditure for the purpose of buying land and building stations and batteries instead of hiring, as at present, must lead to a welcome saving.

GREAT BRITAIN.

The event of July is the launch of the battleship *King Edward VII.*, at Devonport, by the Princess of Wales. This leaves the building slips at Devonport vacant, although there are still being completed there the *Queen* battleship, and several armoured cruisers which have been brought from other ports. At Portsmouth no date has yet been fixed for the launch of the New Zealand battleship, laid down on February 9th, but here the armoured cruiser *Suffolk*, launched on January 15th, is completing. At Chatham the armoured cruiser *Devonshire* is building, and the *Prince of Wales* battleship completing. At Pembroke the armoured cruiser *Duke of Edinburgh*, laid down on February 11th is still upon the stocks, and a new cruiser of the same class is to be laid down shortly, the first consignment of her material having already been delivered. As has now been usual for some time, the process of laying down is not begun until some quantity of material is ready, but a start will probably have been made by the time these notes are published. At Sheerness arrangements are being made for turning the yard into an establishment solely for the work of fitting and repairing torpedo craft.

In the private yards good progress has been made during the past six months in all the vessels in hand. At Laird's Yard, at Birkenhead, the *Topaze*, a third-class cruiser, and the *Blackwater*, a torpedo-boat destroyer, should be launched shortly, the latter, like the *Foyle*, *Itchen* and *Arun*, which have been launched, being of 25·5 knots. Another vessel building here is the third-class cruiser *Diamond*. At this yard refitting work has been done upon the *Hecla*, repair ship, the *Halcyon*, torpedo gun boat, the *Lynx*, destroyer, and torpedo-boats Nos. 52, 53, and 55. At Barrow the battleship *Dominion* is nearly ready for launching, while the *King Alfred*, armoured cruiser, has been delivered. The scout *Sentinel* is also making good progress.

On the Clyde, also, work has been pushed forward very fast during the first half of the year. At the Fairfield Company's yard the *Commonwealth*, battleship, has been launched; the *Bedford*, armoured cruiser, has been delivered, as has the *Donegal*, and both have completed satisfactory trials. In addition, this company is building the *Forward*, scout. Messrs. John Brown have under construction the battleship, *Hindustan*, and the armoured cruiser *Antrim*, both of which should shortly be ready to take the water; and Messrs. Beardmore have delivered the *Berwick*, which has completed her trials, and have still on the stocks the *Carnarvon*. At the London and Glasgow Company's yard there are still the *Roxburgh* and *Cumberland*, the *Monmouth* having been sent up for her trials.

Of the Tyneside yards, Messrs. Armstrong have delivered the *Lancaster* at Chatham for her trials. The *Hampshire* is also expected to take the water at no very distant date, and the small cruiser *Amethyst* is well advanced. The *Adventure*, scout, has not got very far, but, being a smaller vessel than the others under construction there, should go forward rapidly now a start has been made. Messrs. Hawthorn, Leslie and Co. have under construction three torpedo-boat destroyers, the *Derwent*, *Waveney*, and *Eden*, of which the *Waveney* will shortly be under trial; the *Derwent* is very little behind her in readiness, and the *Eden*, which has been built to the order of the Parsons Steam Turbine Company, being also very forward. Messrs. Palmers have also three destroyers nearly ready for delivery, and the third class cruiser *Sapphire*, is still on the stocks.

Coming down to the Thames firms, we find that at Blackwall the *Cornwallis* has satisfactorily completed her trials, being the only vessel of her class to go through them without a breakdown of any sort. The *Black Prince*, armoured cruiser, has at last, after considerable delay, got under way, and is now progressing favourably. The cause of the delay is to be found in the fact that all engine parts have now to be standardised in vessels of the same class, so that they may be interchangeable, a plan on which I have more than once commented in these notes. Messrs. Yarrow have in hand four torpedo-boat destroyers, the *Usk*, *Ribble*, *Trent*, and *Wellend*, all of which are well advanced.

The steam trials of the *Essex* have been completed with satisfactory results. The *Essex* was built at Pembroke, at which port her machinery, designed and constructed by Messrs. John Brown and Co., was fitted on board. At a mean draught of 24 ft. 6 in. the following results were obtained on the three trials respectively: Thirty hours' trial at one-fifth power—steam, 177 lb.; vacuum, 26 in.; revolutions, 81·7; i.h.p., 4,658; and mean speed, 13·84 knots. Thirty hours' trial at four-fifths power—steam, 250 lb.; vacuum, 27·2 in.; revolutions, 121·2; i.h.p., 16,132; and mean speed, 19·28 knots. Eight hours' full-power trial—steam, 275 lb.; vacuum, 26·5 in.; revolutions, 140·7; i.h.p., 22,219; and mean speed, 22·8 knots. It will be noticed that this is not the speed for which she was designed, but it was doubtless considered sufficiently near to the speed to warrant her acceptance.

The *Euryalus*, armoured cruiser, has completed her steam trials after many vicissitudes, and has also undergone gunnery trials. The speed attained with 21·38 h.p. was 21·635 knots, which is well over the contract in both cases. On her gunnery trials, she fired from a 9·2-in. gun, five rounds in 93 seconds, with full charges of cordite in halves and three 80-lb. projectiles. This is an excellent performance for such heavy charges, and one that will take a lot of beating.

FRANCE.

Particulars of the Naval Budget for 1904 have now been made public. The total is £12,517,273, which is rather more than £21,000 less than that for the current year. The items for ships building by contract is increased by £25,600, but for ships building in the Government establishments, there is a decrease of £2,000. For the seamen an additional £64,000 is required, but for the officers the sum has been reduced by £17,000. The expenses of the hydrographic department also are to be reduced by about £4,000, and for guns, £94,800 less than last year is asked. This last seems an extraordinary sum, and I should only be inclined to believe it under reserve.

The armoured cruiser *Sully* has now completed her trials, according to the French press, but details of her speed and other matters are missing. Her coal consumption appears to have worked out at 1·43 lb. per i.h.p. per hour, and the horse-power developed was 10,340. The low rate of coal consumption will entitle the Belleville Company, with whose boilers the vessel is fitted, to a premium of [illegible].

On her preliminary trials, run some little time back the armoured cruiser *Marseillaise*, which is also fitted with Belleville boilers, attained a speed of [illegible] knots, with 10,658 h.p., and a coal consumption of 1·44 lb. per unit of power per hour. At her full-power trial subsequently she made [illegible] knots with a horse-power of 14,[illegible] and a coal consumption of 1·54 lb. per i.h.p. Her boilers worked most satisfactorily, and the results are the more astonishing when it is remembered that, owing to a strike in the dockyards the trial was run with a crew of ordinary naval stokers, the majority of them almost untrained.

The work on the *Victor Hugo* at Lorient has progressed rapidly, and she will shortly be ready for launching. She is to be followed on the slip by the *Jules Michelet*, which will be [illegible] ft. in length, 72 ft. beam, and will displace 12,[illegible] tons. At Cherbourg, also, the *Jules Ferry* is in a forward state, and before these lines are published will probably be in the water.

A torpedo-boat destroyer, *La Bombarde*, was launched on June 26th, at the Forges et Chantiers de la Méditerranée. She is of the same type as the *Sagaie*, recently mentioned in these notes, and is to make 23 knots under forced draught. She will displace 3[illegible] tons. The torpedo-boat destroyer *Javeline* has been completed, and put into commission, as has the *Mousquet*, the former joining the Northern Squadron, and the latter the Mediterranean.

GERMANY.

It seems that in stating that the *Elsass* battleship was launched on May 16th, in my last notes, I made a mistake, as that vessel did not take the water until the 26th of the month.

The battleship *Schwaben*, the last of the *Wittelsbach* class, is now in dry dock, preparing for her trials. If this ship does as well as her sisters have done, the class as a whole will be very satisfactory. The *Wettin* was the most successful, attaining a speed of 18·125, with engines developing 15,500 h.p.

Only one launch of importance has taken place during the past month from the German shipyards. This was at Kiel, where the cruiser *Roon*, hitherto known as the *Ersatz Kaiser*, was launched in the presence of the German Emperor and the Royal family. The vessel is named after the Prussian War Minister, Count von Roon, and Count Waldersee performed the naming ceremony. The *Roon* is of the same type as the *Prinz Adalbert*, slightly modified. She is 403 ft. in length, with a 66-ft. beam, and displaces 9,500 tons. The propellers are of the three-screw type, and the anticipated speed is from 21 to 22 knots. Her guns consist of four 8·2-in. quick-firers, mounted in pairs in barbettes, four 5·9-in. guns mounted in casemates, twelve 3·4-in. and fourteen smaller pieces. She is also provided with four torpedo tubes. A sister ship, known at present as the *Ersatz Deutschland*, is building by Blohm and Voss, at Hamburg.

Some interesting experiments with the 6·7-in. quick-firing guns, with which the vessels of the *Braunschweig* class are to be armed, have been carried out recently at Meppen. The results, of which details are naturally meagre, are believed to have been satisfactory, more especially as the brake, which is to control the recoil of the gun, worked very smoothly, and this will be found very advantageous on board ship, where space is limited.

RUSSIA.

The battleship *Cesarevitch*, which is to be the last vessel built abroad for the Russian Navy, has been under trial at Toulon, but without very satisfactory results. She failed to attain her contract speed of 18 knots, and, like the first ships of our "County" class, the failure was due to defects in her screws, which worked badly, and had not sufficient blade area. They were altered, and when that was done the vessel attained a speed of 18·35 knots. She will go to Kronstadt now, where she is already due, to fit out for service in the Far East.

The battleship *Kniaz Suvaroff*, *Borodino* and *Orel*, are also to leave Russia in the autumn for "a cruise in foreign waters," which may be taken to mean the Far East again. These vessels are the very newest expression of Russian naval architecture. The *Slava*, of the same class, which was laid down last year, has been brought forward rapidly, and is now nearly ready for launching.

The "zakladka," or ceremony of laying one of the plates of the torpedo transport *Volga*, and the launch of the second-class cruiser *Almaz*, took place at St. Petersburg, on June 2nd, and on the same day the first-class cruiser *Kagul* was launched at Nikolaieff. The *Almaz* was laid down on September 25th, 1902. Her length between perpendiculars is 325 ft. ; length over all, 363 ft. ; beam, 43½ ft. ; displacement, 3,285 tons ; engines, 7,500 h.p. ; speed, 19 knots ; capacity of bunkers, 560 tons. Her sixteen Belleville boilers and her two triple-expansion engines, as well as all her other machinery, have been made at the Baltic Works, where the ship was built. About 72 per cent. of the vessel was finished when she was launched. She will carry a number of 1·85-in. and 2·95-in. guns, in addition to six 4·7 guns, which will be protected by 5-in. armour. Progress on the *Almaz* since she was launched has been very rapid. Her boilers, masts and smoke stacks have been put in, and her engines are at the time of writing nearly fitted. She also will leave for the Far East in the autumn. The *Kagul* will be one of the most powerful cruisers in the Black Sea fleet. Her length over all is 439 ft., with a beam of 54 ft. Her displacement is 6,675 tons. She is of the same type as the *Bogatyr*, which was built at the Vulcan yards, Stettin. Her armour-deck runs her whole length, and is 1⅜ in. thick in the centre and 2¾ in. at the sloping sides. Her guns will be carried in two turrets and four casemates, and will consist of twelve 6-in., twelve 3-in., and six 1·81-in. guns. Her engines will develop 19,500 h.p., and give her a speed of 23 knots. Her two torpedo tubes will be submerged, and it is interesting to note that all the material used in her construction has been produced in Russia.

The small cruiser, *Izumrud*, is to be launched during August. She is of the same type as the *Novik*, and will have a speed of 26 knots.

The cruiser *Aurora* has undergone her machinery trials. In four runs over a measured mile, she attained a mean speed of 18·97 knots, and a highest speed of 19·2 knots. The revolutions were [illegible], with a working steam pressure of 180 lb. The coal consumption, however, was very heavy, and the boilers did not work very satisfactorily.

The Ministry of Marine has just ordered three new high-speed tordedo boats for the Black Sea fleet, and five others of 150 tons and 26 knot speed are shortly to be laid down.

UNITED STATES.

The plans for the two 13,000-ton battleships, which are to be called the *Idaho* and *Mississippi*, have been approved. Speed and steaming radius have been subordinated to offensive and defensive qualities, making the vessels as powerful in armour and armament, as other recently projected armour-clads. They are not, however, so fast nor can they steam so far without recoaling,

The following are the principal characteristics of the new vessels :—

Length, 375 ft. ; beam, 77 ft. ; mean draught, 24 ft. 6 in. ; trial displacement, 13,000 tons ; horse-power, 10,000 ; trial speed 16½ to 17 knots.

Battery—Four 12-in. breech-loading rifles ; eight 8-in. breech-loading rifles ; ten 7-in. breech-loading rifles ; twelve 3-in. breech-loading rifles ; six 3-pounders, four 1-pounders, two 3-in. field, two machine, six automatic.

Armour protection—Waterline belt, 9 in., tapered to 7 in. at bottom in way of machinery space, reduced at ends to 7 in., 5 in., and 4 in. ; casemate and athwartship, 7 in ; main turrets, 12 in. and 8 in. ; main barbettes, 10 in., 7½ in., and 6 in. ; lesser turrets, 6½ in. and 6 in. ; lesser barbettes, 6 in. and 4 in. ; sub-barbettes, 3¾ in. ; ammunition tubes, 3 in. ; conning tower, 9 in. ; conning tower cube, 6 in. ; full coal capacity, 1,750 tons.

These vessels, as compared with the *Connecticut*, will have the same main battery excepting only a reduction of the number of 7-in, guns from twelve to ten. The secondary battery is somewhat less than the *Connecticut's*, the principal differences being in the reduction from twenty to twelve 3-in. and twelve to six 3-pounder guns.

It is not intended to fit these vessels as flagships. The weight given to armour protection will be 3,377 tons. The horse-power of the main engines will be 10,000, as against 16,500 in the larger vessels. It is expected that in working out the final designs this power will provide a maximum trial speed of 17 knots. The full coal capacity will be about 1,750 tons, its endurance at 10 knots being estimated at about 5,750 knots.

The torpedo boat *Nicholson* has successfully accomplished her trials, attaining a speed of 25·75 knots. The destroyers *Bainbridge*, *Barry*, and *Chauncey* have all been accepted, and are awaiting commissioning, while the destroyer *Hull* is already in active employment.

WORKSHOP PRACTICE

A RÉSUMÉ OF MACHINE TOOLS, CRANES, AND FOUNDRY MATTERS FOR THE MONTH.

HIGH SPEED STEELS.

MR. H. M. NORRIS has been making experiments with Novo steel, at different speeds, depths of cut, and feeds, with a view to determine its maximum capabilities. The conclusions he draws are that the design of the standard lathe is entirely wrong; firstly, in the gradation of the steps of the driving cones, and, secondly, in the ratio of the back gears. We are unable to find space for an account of the experiments from which these results were deduced, but they were made carefully on stock bars of similar chemical composition and under various rates of cut and feed.

Mr. Norris arrived at the conclusion that until means are devised to compensate for the expansion of work, it is inexpedient to operate on the average grade of steels, at a speed higher than 175 ft. a minute. The maximum speed reached in these experiments, at which moment the tool point was destroyed, was 425 ft. per minute, taking a 1-16th cut, under a feed of 1-64th in. per revolution, when about five cubic inches of metal per minute was being removed. Starting with 175 ft. as a basis, and taking the case of shafts varying from 1 in. to 4 in. in diameter, he shows that it is unnecessary for the lathe spindle to run faster than 688 revolutions or slower than 167 revolutions per minute to do the work. Then, taking diameters between 1 in. and 4 in., varying by $\frac{1}{8}$th of an inch and taking twelve speeds, none of which vary as much as 10 per cent. from the desired speed of 175 ft., he obtains a cone having steps differing but little in sizes: $11\frac{17}{32}$ in., $12\frac{9}{32}$ in., 13 in., which, with a back gear of 2·13 to 1, and a two-speed countershaft, gives the twelve speeds desired. Then he compares this with a standard lathe design, and shows that the latter fails to fulfil the required conditions. The design selected is a five stepped cone, with a back gear ratio of 12·33 to 1, and for a $2\frac{1}{2}$-in. belt against a 4-in. belt on the special lathe. He points out that it is a mistake to try to obtain power at a sacrifice of speed by using back gears of high ratio, and in this he demonstrates and justifies the action of the makers of high-speed lathes and lathes for general work, who

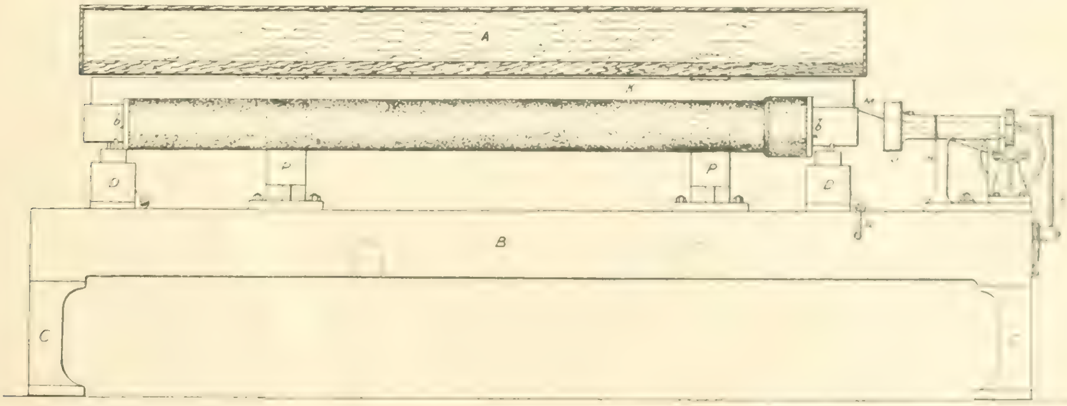


FIG. 1. NEW CORE MAKING MACHINE—FRONT ELEVATION.

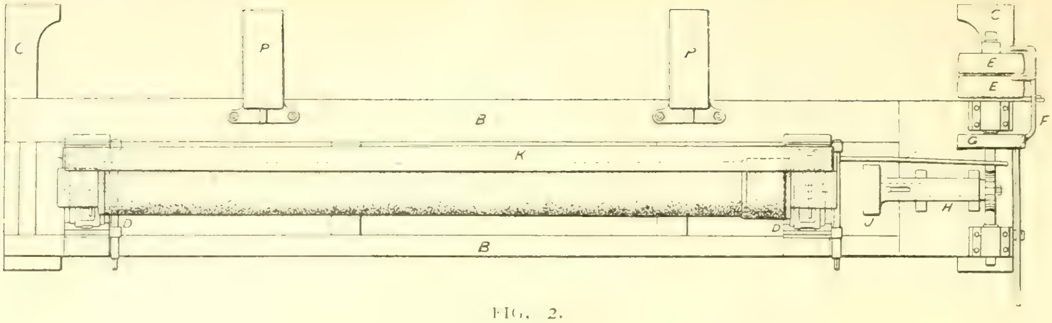


FIG. 2.

now go in for higher belt power on broad cones, and the more restricted use of back gears. This is noticeable in a good many recent lathes.

THE APPLICATION OF ELECTRICITY TO TOOLS.

Mr. Williamson's paper on the applications of electricity, read before the Institution of Electrical Engineers, is the best that has yet been presented on the subject, and the discussion evoked was also most valuable. Mr. Allen's remarks on the abolition of the countershafts, by which 25 per cent. of the power in his machine shop was saved, raises a question which, though not novel is evidently worth more attention than is given to it. Mr. Allen's is not the only shop where the cone pulleys are put on the line shaft, and thrown into and out of operation with clutches, but it may be doubted if the full saving in power that is effected by this arrangement has been appreciated in shops where it exists. The main idea generally is to avoid a short belt drive, and to lessen the blocking out of light. When to these advantages the reduction of power costs by 25 per cent. is added, we may expect the practice to grow rapidly.

Mr. Williamson gave some interesting figures relating to the cost of driving ten lathes by three different systems, namely, by one motor driving a line shaft 110 ft. long, by separate motors with stepped cones, and by separate variable speed motors without belts· the outlays being £410, £575 and £685. Against the latter there is the fact that its working expenses come out least, due to the elimination of bearings, belts, etc. A very interesting case cited is that of the application of a variable speed motor to a planing machine. In this the motor runs at its slowest speed during the cutting stroke, at the end of which it reverses automatically, on which a resistance automatically inserted in the field winding raises the motor speed from 250 to 900 revolutions per minute, which is utilised for the return stroke. At the end of this, the field resistance is short circuited, providing a strong field in which reversal takes place for the cutting stroke.

Day by day the flexibility of the electric drive results in novel applications, and establishes it more securely in favour. New adaptations appear in rapid succession, and, though many are tentative only, to be abandoned in favour of better methods, the net results year after year are immense. The question becomes a serious one in old firms committed to old methods, but no doubt arises as to the selection of motive power in the case of firms that are being newly equipped.

STANDARDISING WORK IN SHOPS.

One aspect of this subject which is grossly neglected in many works, causing considerable leakages, will be found in the slight variations which different draughtsmen are permitted to make in articles that might be of uniform size. Sometimes these are a result of making fine calculations, and embodying them in the dimensions entered on drawings, quite regardless of the economies of manufacture in the shops. Sometimes these little differences are the result of desiring to appear original. In any case, they should be sternly discountenanced by the management.

Take crane hooks, for example ; there is no reason why a different hook should be forged for cranes differing by a ton in load. A 5-ton hook can be used for a 4-ton crane, a 3-ton hook for a 2-ton, and so on. Then such hooks can have their swivels standardised, with the result that the hooks and their parts can be produced in stamps, and stocked by many scores at a time, a twelvemonth's stock, say, being carried at once. The same remarks apply to safety valves and their parts; three or four standard valves will thus answer for eight or ten different engine boilers. Such examples might be multiplied indefinitely. It is useless to attempt to economise with moulding machines, smiths' dies, turret lathes, automatics and other special tools unless the small variations and odd thirty seconds, sixteenths and eighths of an inch are ruthlessly eliminated, and the standard parts reduced to the last minimum practicable that is consistent with good engineering.

ELECTRIC CRANES.

The question of hydraulic *versus* electric cranes raised by Mr. Walter Pitt at the Civil Engineers' Conference, naturally gave rise to different expressions of opinion. Engineers cannot well help running in grooves, and those who know most about either system are naturally prejudiced strongly in favour of that one, But philosophical, disinterested observers cannot

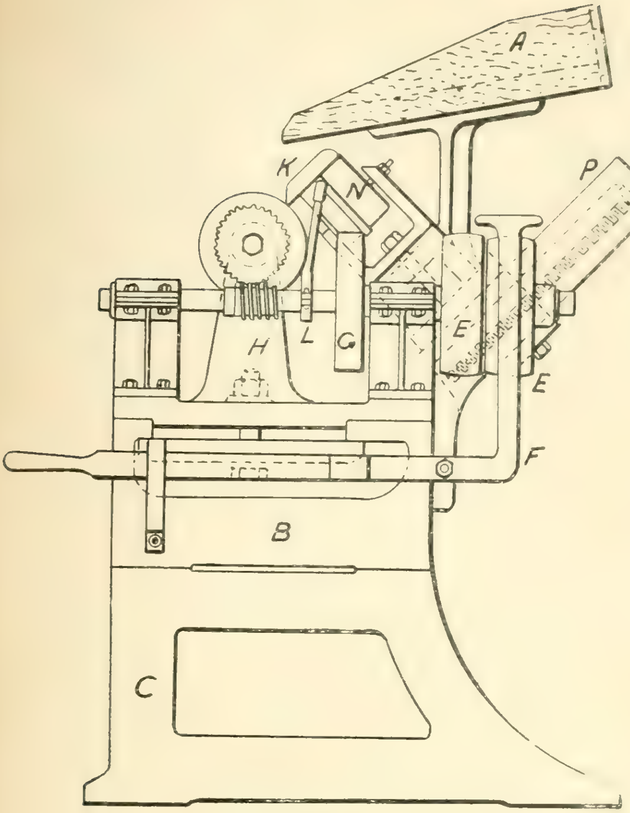


FIG. 3.

help seeing that the electrical system possesses several obvious advantages over the hydraulic for average crane service of harbours and docks. These points were well summarised by Mr. Pitt when he said that "the electric transmission of power can do everything that the hydraulic transmission of power can, and a great deal more besides, and it does it at a cheaper rate. With the same set of engines and boilers, every appliance that requires power can be driven, the workshops can be kept running, and the docks can be lighted, and there is that combination of a day and a night load which is dear to the heart of every electrical engineer."

The two cranes recently erected on the Admiralty Pier at Dover are a step in the right direction. It has been rather a reproach that, while electric cranes have been in use on the other side of the Channel, and while Southampton has had them for many years, Dover has been destitute of them. These new cranes are high speeded, being designed to lift 3½ tons at 120 ft. a minute. A complete revolution is made in one minute, the speed attained being from 250 ft. to 350 ft. The speed of travel is 100 ft. per minute. The cranes are of the two motor type, the one for lifting developing 37 h.p. at 420 revolutions per minute; the other, used both for slewing and travelling, develops 11 h.p. at 420 revolutions per minute. Current is taken from the Corporation supply at 500 volts.

A NEW CORE-MAKING MACHINE.

A very ingenious core-making machine has been put on the market by Messrs. Jones and Attwood, of Stourbridge. It embodies the striking board principle, but instead of using loam or oil swept up cores, green or dry sand mixtures are employed as in cores rammed in boxes. Figs. 1, 2 and 3 show the machine in front elevation, plan, and end elevation respectively, and illustrate the mechanism of the machine clearly.

The sand required is stored on the adjustable shelf A, made of wood, and supported on brackets, S, which also fulfil another function, to be noticed presently. The brackets, together with the mechanism of the machine, are carried on the bed, B, of the machine, supported on the standards, C, C. The core bar or barrel runs on rollers in the brackets, D, the height of the bar being adjustable through rack and pinions operated by the handle [illegible]. The diameters, which can be struck up, range from 2 in. to 20 in. There is no tentative setting, and measuring with calipers required, the diameter being fixed by collars in the manner sometimes adopted in sweeping up standard pipes and column cores. The bar is rotated from belt pulleys, E, E, fast and loose, the striking gear being shown at F, but hand gear can be substituted if desired. G is a small flywheel on the main shaft, that runs in the bracket, H. This shaft drives worm gear, seen in each view, the worm wheel being on a short spindle in the headstock. It makes from six to eight revolutions per minute. The core bar is coupled to this by means of a driver or sliding collar J. As it is slowly revolved, the striking bar K, which is one of wood, lined with steel, is reciprocated rapidly against the sand, making from 250 to 300 strokes per minute, and pressing the sand against the bar. It is this peculiar reciprocation that distinguishes its action from that of ordinary striking bars, consolidating the sand around the bar. The nearest parallel I can think of is that of the consolidation of electrically deposited copper pipes. The result is a close core, such as would be produced by ramming in a box, and a smooth surface. The reciprocation of the bar is effected by an eccentric L on the shaft, H, and a rod, M, which communicates its motion to the bar. The bar is carried on the rollers N. The latter are carried in brackets, O (see the end view), and these slide in saddles, P, fitted with screws by means of which the striking bar is adjusted for diameter. The same movement which adjusts the bar also carries the sand shelf with it.

LOCOMOTIVE ENGINEERING NOTES.

A Third Alternative.

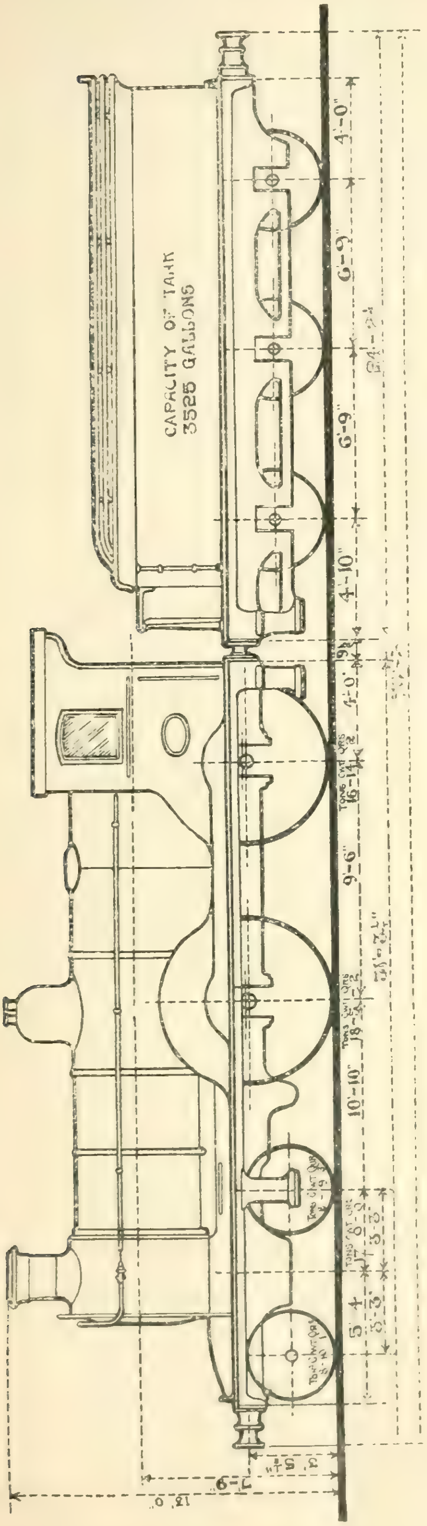
The references to the locomotive novelties in course of incubation or production at the Swindon Works of the Great Western Railway, which appeared in this column of last month's issue of PAGE'S MAGAZINE, may, perhaps, have seemed to extend to a somewhat undue length. Yet there is one more point which the writer would regret to pass by unnoticed. Hitherto, it has been generally accepted that a locomotive must take its steam from the boiler in one of two ways. It may either be taken by the regulator from the upper part of a steam dome or else it may be collected by means of a perforated pipe along the top of the boiler. It has always been assumed that by no other means could the steam be obtained in a sufficiently dry condition. For many years the Great Western, like the Great Northern and South-Eastern, adhered to the domeless boiler with the perforated pipe. Then, as in the case of those other railways, it "'verted" to the prevalent fashion of the steam dome. Latterly, it has once more *re*verted to the domeless boiler with the perforated pipe. But with the new so-called "taper" or "extended wagon top" boiler, Mr. Churchward finds that he can take his steam from the highest point in the boiler in an amply dry state without the intervention either of dome or of perforated pipe. The abandonment of the dome has become virtually compulsory by the great height to which the latest boilers are raised; but its loss is not deemed a matter for regret, inasmuch as, however ingeniously its fitting may be designed, the steam dome does necessarily and unavoidably weaken the barrel of the boiler. On the other hand, there have been thought [illegible] disadvantages attaching to the perforated pipe [illegible]. Thus, if the new and third alternative [illegible] with both, possessing as it does [illegible] simplicity of method, proves to work with entire satisfaction in practice, another new departure both valuable and interesting will have been advantageously taken.

A Glasgow and South-Western Novelty.

Some months ago the present writer ventured to express the view that both the "Atlantic," or "4-4-2," and the six-coupled bogie, or "4-6-0," types of express locomotives had "come to stay" in Britain. Several instances were then noted of the growing tendency in this country to adopt one or both of these types. Two more accessions to this list have to be recorded in the present month. Mr. James Manson, Chief Mechanical Engineer of the Glasgow and South-Western Railway, recognising that locomotive dimensions which may have been thoroughly adequate in the "eighties" are no longer sufficient for coping with the increased loads and speeds now required, has followed the example of Mr. Worsdell, Mr. P. Drummond, Mr. Robinson, Mr. Churchward, and Mr. M'Intosh in adopting the six-coupled express bogie design, somewhat ambiguously known in America as the "ten-wheeler." Mr. Manson has designed a very handsome and powerful-looking engine, of which ten either have been built or are in course of construction, some being at work. The six-coupled driving wheels are 6 ft. 6 in. in diameter, as in the case of the new Caledonian giants, but the cylinders are 1 in. smaller in diameter, namely 20 in. instead of 21 in., and are placed outside instead of inside the frames. The piston stroke is 26 in. in length, and the connecting rod drives the middle pair of coupled wheels. To supply the 20-in. by 26-in. cylinders, Mr. Manson has provided a large boiler with 1,85[illegible] square feet of heating surface, and a steam pressure of 180 lb. per square inch. The tractive force of the new engine is 133 lb. for every lb. of effective pressure in the cylinders, and as the total power obtained by multiplying this force into the steam pressure is taken up by six wheels, it is manifest that the new engines ought to be able to pull heavy loads in all weathers, up even the excessively steep grades of the Glasgow and South-Western, which, coming south from Glasgow, are as much as 1 in [illegible], and even 1 in 67 against the engines. The new departure is unquestionably a wise one.

A North-Eastern "Atlantic."

Mr. Wilson Worsdell, Chief Mechanical Engineer of the North-Eastern Railway, was the pioneer in this country of the six-coupled express bogie engine,



BOGIE PASSENGER ENGINE, BUILT BY THE NORTH BRITISH RAILWAY COMPANY.

Total Weight of Engine and Tender in working order, 92 tons. Total Heating Surface, 1,577 sq. ft. Boiler Pressure, 220 lb. per sq. in.

as were Mr. Ivatt and Mr. Aspinall of the "Atlantic" type. But Mr. Worsdell has now come to the conclusion that locomotives of the latter design may with advantage be added to the very fine ones of the "4-6-0" order which he already has at work. He has accordingly designed and is now building a new four-wheel coupled express engine of the "Atlantic," or "4-4-2," type, which, when completed, will be by far the largest and most powerful four-coupled engine ever seen in this kingdom. Indeed, its dimensions will fall little, if at all, short of those of the new Caledonian colossi. The driving wheels are to be 6 ft. 10 in. in diameter with new tyres, as in the case of their latest predecessors in the four-coupled class, Nos. 2101, etc. But the cylinders will have an inch larger diameter, being 20 in. instead of 19 in., and the piston stroke will be lengthened by 2 in., namely from 26 in. to 28 in. It is in the boiler, however, that Mr. Worsdell's new engine displays the most remarkable development. It will be 16 ft. 10½ in. long, and no less than 5 ft. 6 in. in diameter. The tubes will afford a heating surface of 2,275 square feet, to which 180 square feet will be added by the firebox, making a total of 2,455 square feet. The engines will weigh somewhere about 72 tons. They certainly ought to be able to grapple with any present or prospective requirements on the North-Eastern line. That is to say, they should be able to keep the fastest probable timing with the heaviest loads that can possibly be accommodated at North Eastern stations. It will be highly interesting to compare the working of these new four-coupled giants with that done by the six-coupled "2111" class, and also by the Caledonian Goliaths, Nos. 49 and 50.

Locomotive Megalomania.

Are we entering upon a period of dimensional excess in respect of locomotives? Are our locomotive engineers, in fact, being carried away by that craving after immensity which the ex-Premier, Lord Salisbury, once censured under the term "megalomania," when, in his opinion, it unduly influenced the London County Council? There are not wanting many engineers, especially the elder ones, who emphatically declare that this is the case, and that the vast dimensions now resorted to on British railways, Continental and American example being followed in this respect, are altogether excessive, unwarranted, and uncalled for. It is freely asserted that the new colossal locomotives are unjustifiably costly, that they will also prove exceedingly expensive in upkeep, repairs, and fuel-consumption, and that their use will tend to enhance the cost of permanent-way maintenance. It is, perhaps, hardly necessary for the present writer to say that he dissents as diametrically as possible from these views. That the adjectives above quoted, divested of their accentuating adverbs, may be true enough in themselves, he is quite prepared to admit as a general rule. It is impossible to build such engines as those just referred to for the same price as the little "Precedents" on the London and North Western or the "Gladstones" on the London, Brighton, and

South Coast. That, in view of the enormously heavier work which they will have to do the actual coal consumption per mile and the repairs bill per engine may and will be increased, is highly probable—almost certain. Nor can the likelihood be denied that some strengthening or improving of the permanent way and certain enhanced assuidity in its upkeep may be necessitated by the employment of locomotives weighing between 70 and 80 tons exclusive of their tenders. That this may also be taken for granted the writer is not prepared to dispute. But these things are all relative. It may be that each of those items of expenditure will be larger *per se*, and yet be materially lower proportionately to the work done.

A Comparison.

Not long ago the question was pointedly put to the writer why the repairs bill per locomotive on leading American lines was heavier than that per engine on the English railways. The facts appeared to be as stated, but on turning up the respective figures a satisfactory explanation was immediately forthcoming. For the accounts showed that although the repairs bill per engine was undoubtedly heavier on the American railways, each American engine had done so much larger an amount of work than the average British engine, that proportionately to the work done, the American engines cost much the less of the two. The difference was clearly due to the larger size and superior power of the Americans. And this has now come to be so fully recognised in Great Britain that it may fairly be predicted we shall see very few engines designed or constructed for our leading lines on the restricted scale that has been too long in fashion in these islands. It may also be predicted with some confidence that the financial results will prove to be substantially favourable.

"Cheap" but not "Nasty."

But even in point of actual positive cost, the new locomotive giants that are now being turned out in such numbers are by no means always expensive. By maintaining careful watchfulness over the market as regard the price of material, by exercising judgment as to the time and extent of purchases, and by skilful management of the workshops, it has proved feasible to construct even the most powerful locomotives in the Kingdom at a cost actually less than that of many other British engines which possess only 50 to 75 per cent. of their effective power. For instance, the writer has reason to believe that certain very fine and effective four-coupled express bogie engines which were constructed not long ago for one British railway, cost something like £4,000 a piece. Yet he also has reason to believe that Nos. 49 and 50 on the Caledonian Railway cost barely £3,100 each. Therefore it is evident that increased size and power do not *necessarily* spell enhanced cost. Of course, the writer is not prepared to assert that such remarkably economical construction would be feasible in all cases. Still, the fact that it has proved practicable in this particular case may at least serve as an encouragement to those engineers who would willingly design and build larger and more powerful locomotives were they not afraid that the increased cost would be misunderstood, and perhaps resented by their directors and shareholders.

A New North Britisher.

A new class of express locomotive has recently come out on the North British Railway. It would be inaccurate to style it a new "type," because the type is strictly that introduced by the late Mr. Matthew Holmes, the lamented ex-Superintendent of the North British Locomotive Department, a few years ago, of which No. 729 was the pioneer. No. 317, the first of the new engines, is virtually No. 729 over again, with larger boilers and cylinders. In fact, No. 317 may be said to bear the same proportion to No. 729 on the North British as "Breadalbane" to "Dunalastair" on the Caledonian Railway, for whereas the earlier of the two classes had $18\frac{1}{4}$-in. cylinders and approximately 1,400 square feet of heating surface, the new ones have cylinders 19 in., and approximately 1,500 square feet of heating surface. With cylinders 19 in. by 26 in., and 6-ft. 6-in. wheels, four-coupled, the newest North British engine possesses 120 lb. of tractive force for every lb. of effective steam pressure on her pistons, as against 111 lb. in the case of her predecessors. No. 317 and her sister engines ought to do good work on the North British main line.

A New Railway "Record."

On July 14th the Great Western set up a new "record," or rather a series of "records." The Royal Train, conveying their Royal Highnesses the Prince and Princess of Wales to Cornwall, passed Reading (36 miles) in $33\frac{1}{2}$ minutes after leaving Paddington; Bath (107 miles) in 92 minutes; Bristol ($118\frac{1}{2}$ miles) in 1 hour 44 minutes; Exeter ($193\frac{3}{4}$ miles) in 2 hours 52 minutes 34 seconds, and arrived at Plymouth (246 miles) in 3 hours 53 minutes 35 seconds. This is a "record" for each of the points named, and so is the speed for so long a distance, the average to Exeter ($193\frac{3}{4}$ miles), being 67·3 miles an hour, and to Plymouth, after climbing the tremendous grades of South Devon—1 in 42, 1 in 43, etc.—being 63·4 miles an hour. The engine "City of Bath," was one of Mr. Churchward's latest class with 6-ft. 8-in. wheels, four-coupled, and cylinders 18 in. by 26 in. The load consisted of five bogie eight-wheelers weighing about 130 tons in all. The writer travelled by the train and kept a minute record of the work, to which he may refer again later.

C. R.-M.

PAGE'S MAGAZINE

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OUR MONTHLY RÉSUMÉ.

LONDON, July 20th, 1903.

Shipbuilding Retrospect.

The shipbuilding half-year, which has terminated since our last number was made up for press, has not been a brilliant one. It has, of course, been marked by labour disputes and with uncertainties as to the iron market. And it has also been marked by the law of diminishing returns. In the case of Scotland, which ranks first in bulk of production among the several districts, the output of the six months has been only 208,440 tons, as compared with 259,800 tons in the corresponding six months of 1902, with 246,752 tons in 1901, and with 232,584 tons in 1900. In fact, there has been nothing so low since 1897, when the total was 159,450 tons. In England the output has been 305,582 tons, as against 354,030 tons. The total of the United Kingdom was 565,340 tons in the first six months of 1903, and it is to be feared that the total of the second six months will be very much smaller. During the summer there has been and will be very little new booking, but some hopes are entertained that by September a revival of interest in the shipyards may be shown by shipowners. In shipping circles, however, one hears so much of boats kept running at a loss, of fleets supported by paper, of gathering mortgages and accumulating charges, that one's hopes are chastened.

Combine Disillusionment.

However bad our shipping and shipbuilding may be as industries, they are radiant when compared with those of America. The *débacle* of the United States Shipbuilding Combine is not only an object-lesson in combine-mongering; it is also a revelation in American shipbuilding. That this combination should have depreciated by nearly forty millions dollars in a twelvemonth of trading is not credible. It was, of course, enormously over-capitalised, but then it does not seem to have made a cent of profit, although its yards have on hand so many vessels for the United States Navy. For one thing, the Shipbuilding Combine does not seem to have been supported by the expected orders for new ships from the Morgan Shipping Combine. This is not surprising, for the Morgan Combine are finding out not only that they paid far too much for their steamers, but also that the Atlantic shipping trade is by no means always a money-making business. It will be very much the reverse under the war of rates which is impending while we write. The Combine are laying up some of their vessels, but, on the other hand, the earnings of the White Star Line (perhaps the only profit-making part of the combination) are increasing. An impending reorganisation of the Morgan Combine is alternately asserted and denied.

Wages in the Shipbuilding Trade.

The following information about wages in the shipbuilding trade will be of interest. It is obtained from the Secretary of the Employer's Federation. The Clyde Engineers' Association comprises in its membership practically the whole of the marine and general engineering industry in the Clyde district. In their engineering departments the members of this association employ about 16,000 journeymen and apprentices. The principal trades are engineers (fitters, turners, etc.), pattern makers, brass workers, and blacksmiths. The majority rates are as follow: Engineers, fitters and turners, [illegible]d. per hour; machine-men, 5d. to 9d. per hour; pattern makers, 8·25d. to 8·50d. per hour: brass finishers, 7·75d. per hour; brass moulders, 8d. to 8·25d. per hour; blacksmiths, 7·75d. to 8·25d. per hour; sheet metal workers, 8·25 to 9d. per hour; enginemen, cranemen, firemen, 4·50d. to 5·50d. per hour; and labourers, 4d. per hour. For the period from January, 1899, to March, 1900 the percentage of lost time for engineers proper varied from 3·93 to 4·79 per cent. on average; patternmakers, from 3·25 to 3·90 per cent. on average; brass-finishers, from 4·29 to 5·04 per cent. on average; brass moulders, from 5·27 to 6·76 per cent. on average; and blacksmiths from 3·93 to 4·33 per cent. on average.

The men employed in the marine engine shops of the Clyde number 12,000 journeymen and 4,000 apprentices. These figures include about 1,800 labourers. The majority rate for labourers is 4d. per hour. There are 74, or 4·20 per cent., under 3¾d. per hour, and 241, or 13·70 per cent., at 3¾d. Some of these men earn up to 6d. There are in all 315 out of 1,763 under 17s. per week. The members of the Association also employ in their boiler shops over 5,000 journeymen and apprentices. The principal trades are platers, riveters, caulkers, blacksmiths and angle iron smiths. The majority rates are as follow: Platers (heavy), 9·25d. per hour; platers (light), 8·50d. per hour; riveters and caulkers, 8d. per hour; angle-smiths, 9·25d. per hour; blacksmiths, 8d. per hour; machinemen, 4·25d. to 9·75d. per hour; enginemen, cranemen, firemen, 4d. to 6d. per hour; hammer men, helpers, and labourers, 4d. to 5d. per hour. Boilermakers on piece earn on the average not less than £3 per week. Out of the 5,000 employed there are 4,400 journeymen and 700 apprentices. The majority of the men who earn about 17s. per week have no families. They are either old men past their best, or young men just starting, who in time may graduate as platers' helpers. For the period from January, 1899, to March, 1900, the percentages of lost time were: Platers, 7·72 to 8·99 per cent. on average; riveters and caulkers, 7·68 to 8·07 per cent. on average; holders-on, 8·85 to 9·62 per cent. on average; blacksmiths, 3·21 to 4·81 per cent. on average; and angle-smiths, 8·08 to 12·87 per cent. on average. The angle-smith belongs to the "black squad," but the blacksmith is a member of the Associated Blacksmiths' Society.

As to the wages of unskilled men. Of shipyard labourers, 24·77 per cent. at majority rate, 4d. per hour; 22·82 per cent. under majority rate; 52·41 over majority rate; engine shop labourers, 26·31 per cent. at majority rate, 4d. per hour; 17·90 per cent. under majority rate; 55·79 per cent. over majority rate. Boiler shop labourers, 52·48 per cent. at majority rate, 4d. per hour; 25·52 per cent. under majority rate; 22·00 per cent. over majority rate. Time hammermen (shipyard), 43·74 per cent. at majority rate, 4·75d. per hour; 40·08 per cent. under majority rate; 16·18 per cent. over majority rate. Time hammermen (boiler shop), 42·24 per cent. at majority rate, 4·75d. per hour; 35·54 per cent. under majority rate; 22·22 per cent. over majority rate. Platers' helpers (boiler shop,) 24·60 per cent. at majority rate, 4·50d. per hour; 42·58 per cent. under majority rate, 4·50 per hour; 32·82 per cent. over majority rate.

Fluctuations.

The following shows the fluctuations in wages in the Clyde district since 1890: Shipyards—ironworkers, 5 advances, equal to 20 per cent. on piece and 1¼d. per hour; reductions—4 on piece, equal to 20 per cent.; 3 on time, equal to ¾d. per hour. Shipwrights—4 advances, equal to 1d. per hour, and 3 reductions equal to ¾d. per hour. Joiners—5 advances, equal to 1¼d. per hour, and 2 reductions, equal to ½d. per hour. Blacksmiths, 5 advances, equal to 1½d. per hour, and 3 reductions, equal to ¾d. per hour. Engine and boiler shops—Blacksmiths, 4 advances, equal to 1¼d. per hour, and 2 reductions, equal to ½d. per hour. Boilermakers, 5 advances, equal to 1¼d. per hour, and 2 reductions, equal to ½d. per hour. Engineers, 5 advances, equal to 1½d. per hour, and (plus a further equalising advance of ¼d. per hour), and 2 reductions, equal to ½d. per hour.

Belfast and its Output.

The visit of the Institution of Naval Architects to Belfast has called attention to what this city has done in shipbuilding. In spite of the great natural difficulties due to the absence of coal and iron, on which Lord Glasgow commented, in Belfast during 1902, 19 vessels, aggregating 157,464 tons were launched, an amount greater than the whole output of mercantile steam tonnage of any other entire European state, except Germany. Of the total, above 79,500 tons were launched from Messrs. Harland and Wolff's yard, and nearly 76,000 tons from Messrs. Workman and Clark's yard. Belfast, unlike any other large shipbuilding centre, counts but two important firms, which between them turn out as large a tonnage as almost any other shipbuilding centre in the country. Out of the seventy largest vessels afloat of 10,000 tons and upwards, Messrs. Harland and Wolff have built no less than 35, of an average tonnage of 12,618. Size has always been a feature of this firm's work, and the three great ships, *Oceanic*, *Celtic*, and *Cedric* (the largest vessels afloat) are examples of what modern enterprise and skill can do. To undertake the building of such vessels, and to be able to do so expeditiously and economically, advantage must be taken of every appliance that modern invention has perfected for the special class of work in view. Messrs Workman, Clark and Co. have grown with great rapidity, and last year the firm launched twelve vessels, representing 75,932 tons and 46,900 h.p.

The Late Sir E. J. Harland, Bart.

Perhaps the most interesting feature of the visit was the unveiling of a statue of the late Sir E. J. Harland, Bart. The project first assumed practical shape in 1895, when, at a meeting of friends and admirers of the baronet, the following resolution was passed :—

"That, with a view of providing a permanent memorial to the late Sir Edward Harland, who, by his indomitable perseverance, ability, and sagacity, created and brought to perfection in our city the great industry of shipbuilding and engineering on the Queen's Island, whereby employment was given to many thousands of people, and the trade of the city vastly increased, and who not only discharged his duties as alderman and mayor, but also as chairman of the Harbour Board, and member for the North Division of Belfast, in a manner which reflected the greatest credit upon himself and upon the city, we are of opinion that a statue should be erected in Belfast to his memory."

The statue, which has been executed by Mr. Thomas Brock, R.A., occupies a site in front of the new City Hall, and its attitude is described as thoroughly characteristic of the alertness and vigour of the subject. In unveiling the statue, the Earl of Glasgow remarked that Sir Edward Harland's services and success were well known to all present. He was a type of a successful self-made man, who made his own way from the bottom of the ladder to the top, and who during his life rendered inestimable services to the shipbuilding interests in that distinguished and great city. He was a very original naval architect. He was the first to advocate the increased length of ships, which had given such great carrying capacity to their large sea-borne vessels. Sir Edward Harland was not the man to confine himself to working in his own profession. As a member of Parliament, as mayor of their city, and as head of their Harbour Board, he showed his business capacity and his interest in the work of the community, and in all respects, as he was told, Sir Edward Harland was a most faithful and capable citizen of that great city.

At the dinner given in honour of the Institution by the Right Hon. W. J. Pirrie, D.L., at Ormiston, that gentleman paid a graceful tribute to the memory of his late partner, remarking that in Sir Edward Harland they had had an example of boundless energy, quick perception, the power of initiation and adaptation—which is the true engineering instinct—combined with sound technical knowledge; and in the works which he established they had an illustration of what the application of these qualities could do.

Nautical Training as Developed in America.

"If one can imagine a well-equipped preparatory school, completely furnished dormitory, library, gymnasium, museum, laboratory, and an efficient corps of instructors, placed upon a big ship, and, with the pupils taken round to the various countries of the world, he would form a very good idea of the Nautical Preparatory School of Providence, R.I." *Marine Engineering* thus refers to a notable project which is being carried out in America. The purpose is to take young men and prepare them while afloat, visiting the principal countries of the world, for college or a business life. The students will be given a combination of theoretical schooling, practical training, and observation with world-wide travel on board a large steel full-rigged ship, instead of within the four walls of a building on shore. The course of study will comprise those usual in preparatory schools, the work being conducted by twenty-five professors and instructors. The number of pupils will be limited to two hundred and fifty.

Protracted cruises over many seas, visits to all lands, and contact with a great variety of people and customs, give unequalled opportunities for special studies, such as commerce and economics, science and natural history, that it would be impossible to obtain if ashore.

The *Young America* is the name to be given to the ship, which will be a full-rigged steel sailing vessel, with auxiliary steam power of modern type of construction.

South African Mines.

A battery of five head of Morison's high speed stamps has been erected at the Meyer and Charlton mine, and is to have a thoroughly practical trial. A mill on somewhat similar lines, designed by Mr. Morison, was worked in British Columbia some years ago at a speed of 132 drops per minute, with 8-in. drop and 1,140-lb. stamps. It crushed at the rate of nearly seven tons per stamp per day, with 600 mesh screens, and over 8½ tons with 400 mesh, but, owing to sundry breakages the inventor decided to carry out a number of experimental tests on a large scale, with a view to making the machine more perfect and reliable before putting it again upon the market. Mr. Morison, assisted by Mr. D. A. Bremner, has spent nearly three years in overcoming various difficulties, and in making improvements in details to render the mill capable of working continuously under the ordinary trying conditions which occur in ore crushing: and the present battery is the result of those efforts. The cam is dispensed with in favour of a simple form of piston and cylinder, which lift the stamp on an air cushion, but allow it to fall simply by gravitation. We hope soon to be able to give full particulars and illustrations showing how 1,000-lb. stamps are driven at 126 drops per minute.

Treatment of Cyanide Residues.

In an article somewhat imaginatively styled "A Thousand New Gold Fields," *The South African Mines, Commerce and Industries* draws attention to a new "process" applicable to the profitable treatment of cyanide residues on the Rand. Mr. [illegible], Government Mining Engineer, reports that while it would not be prudent at this stage of the development of the process to give definite figures as to the increased profits that would be derived through the general adoption of the process throughout the Rand, those who are responsible for making a success of the treatment on a large scale at the Crown Reef are confident that the existing dumps of cyanide residues on the Rand, as well as future dumps that will be made, can be successfully treated. And what is the process?

"It has long been known," says our contemporary, "that cyanide residues hold large quantities of gold till now unrecoverable by any known process. A small spring issuing from the Crown Reef dump was discovered to contain a small quantity of gold. Recent experiments go to show that the weathering of the residues provides the hitherto vainly sought solvents; and the simple process of percolating water through the dump affords the 'open sesame' to the hidden riches."

At first it was surmised that the cyanide solution remained in the dump and was itself the solvent that brought the gold in solution. The untenability of this was patent to those who had learned that cyanide solution is decomposed in the presence of acid of which there is abundance in tailings and slimes dumps, together with a great deal of lime and alkali. Therefore, cyanide residue solution could not have been the solvent. Mr. Stark has satisfied himself and his management that the solvents are thiosulphates found in the dump. The solvent consequently exists in the dump, the extent of which it would seem, is the only limitation upon the possibility of the so-called process, which consists merely in pouring water upon the dump. All that appears to be needed is a pipe, water, and percolation. When taken up the gold in solution is collected and led into a tank. There the gold is precipitated by means of wire gauze battery screening.

Treatment of the Crown Reef dump was started in November, 1902. A steadily increasing recovery has resulted since that time and at a very low cost. It is stated that the discovery has already led to the purchase of cyanide residues.

South African Iron and Steel.

At the annual meeting of the South African Association for the Advancement of Science, held at Capetown, Sir Charles Metcalfe, Bart., M.Inst.C.E., in the course of his presidential address, alluded to the vast possibilities of South Africa as a centre of iron and steel production. It was worthy of notice, he remarked, that, whilst the cost of coal-mining varied considerably, coal was now produced at one or two mines in the Transvaal for 4s. a ton at the pit's mouth, which compared favourably with anything achieved in Europe, though it [illegible] in some of the Pennsylvanian coalfields where coal was said to be put on trucks for a total cost of 2s. 6d. a ton. The coal production of the world was estimated to be about [illegible] million tons, of which the United States produced about [illegible] million tons, the United Kingdom about [illegible] millions, and Germany [illegible] millions. There were vast deposits of iron in South Africa unworked, save by the Kaffirs. Let them hope that the change might come, and come quickly, and that they might themselves see iron and steel manufactories established in that country. The cheapening of steel and iron would mean perhaps more to South Africa than to most countries, for not only would there be an enormous demand for rails, bridges, galvanised iron and fencing, structural steel for high buildings, and warehouses, and all the other steel and iron ware, but there was in South Africa no construction timber grown—that was the timber most largely consumed in engineering work and in buildings, and as such wood got dearer, and steel work got cheaper, there would come a time perhaps in the near future, when steel and iron would be used, perhaps fortified with concrete, in the construction, not only of tall structures and giant edifices, but in dwelling-houses and cottages, instead of timber.

The Irrigation Question.

One of the most important papers read at this Conference dealt with the irrigation question in South Africa, this subject being introduced by Mr. W. Westhofen, M.Inst.C.E., who urged that the climatic conditions prevalent in South Africa, and the uncertainty and insufficiency as well as the inequality in distribution of the annual rainfall, made it absolutely necessary that irrigation should be resorted to so far as the production of foodstuffs was concerned. Thousands of miles of fertile land were lying waste—more particularly in Cape Colony—owing to the want of this most essential adjunct to agriculture and husbandry under a semi-arid climate. The first reason named by Mr. Westhofen for the want of progress shown in this matter was that all public works were to a great extent looked upon in South Africa as counters in the political game. The majority of country members in the House of Assembly could not realise that only by co-operation and by working in a united manner for the benefit of the whole colony could any material success be achieved. Another hindrance was the non-existence of the efficient and comprehensive laws dealing with the ownership of water and its apportionment. Although the subject had been brought to its notice year after year for nearly half a century, the Legislature of the Colony had never yet made a serious effort to establish a code of laws which would once for all settle the vexed question of water rights. Reviewing the various acts which had been passed in connection with irrigation, he remarked that in none of these had an attempt been made to touch the thorny subject of water-rates or to define these in any way. Consequently, in all cases where disputes about water-rates could not be settled amicably or by arbitration, recourse must be had to the supreme court of the Colony—a fact which had a most deterrent effect upon the investment of capital in irrigation enterprise. Other reasons why irrigation enterprise had not prospered were want of capital, want of experience, ignorance of the best methods of storing water or of applying it to the best advantage when it was available, absence of public spirit, and disregard of the value and the advantages of co-operation among the persons most interested.

He urged that the construction of roads and railways should go hand in hand with irrigation works, which would help to make the railways pay, and which might ultimately not only provide the foodstuffs for the people of the colony, and so make it self-supporting, but might even open up a trade with other countries in articles which were now imported in large quantities. He emphasised the need of a proper hydrographic survey. Such a survey would disclose the localities where permanent weirs might be constructed to retain some of the water which now, after heavy rain, disappeared into the sea in the course of a few hours, thus robbing the agricultural lands of an inestimable benefit.

Many of the Colonial rivers, such as the Orange, the Great Fish, the Oliphants, the Gamka, the Gouritz, and many others, carried with their flood waters into the sea immense quantities of soil and organic substances extremely valuable as fertilising agents. A series of low weirs with sluices in each would hold up the greater bulk of such matters, and when the floods had subsided the sluices could be gradually opened, the water drained off, and the deposits allowed to solidify, after which they could be carted away and deposited upon the poorer lands and ploughed in. Or in places where the configuration of the ground was suitable, the silt-laden flood waters could be led upon such lands direct. In conclusion Mr. Westhofen said it was only fair and just to acknowledge that the present Government, since peace had been proclaimed, had in the person of the Commissioner of Public Works, the Hon. Arthur Douglass, taken active and energetic steps to place the subject of irrigation in the fore-front of public works to be carried out in the immediate future. All those interested in the question might look forward with hope and confidence to an era of prosperity and progress in the Colony.

Transvaal Meteorological Department.

The Meteorological Department recently established by the Transvaal Government will be of great assistance later on to engineers who have to deal with water supply and irrigation. A first order station will be established probably on the high ground to the north of Johannesburg, and twenty-five second order stations will be evenly distributed over the area of the colony. At these daily readings will be taken of the barometer, rain gauge, hygrometer, and maximium and minimum thermometers. If sufficient observers can be found who will undertake the charge of gauges and make the necessary records there will also be two hundred additional stations where the rainfall only will be observed at present. The instruments for this purpose and for the second order stations are now on the way out from England.

The Proposed English Charlottenburg.

It would be impossible to over-estimate the national importance of the scheme announced by Lord Rosebery, under which, by the munificence of certain public-spirited philanthropists, it is proposed to furnish the metropolis with an English "Charlottenburg." Lord Rosebery strikes at the root of our deficiencies in technical education when, in the language of the Technical Education Board, he says that "several of our industries have suffered, and are still suffering, from our failure to organise, not so much technical education of the ordinary type as the more advanced instruction in scientific technology and facilities for original research."

Messrs. Wernher, Beit and Co., Sir Ernest Cassel, Lord Strathcona, and others have made the scheme possible by munificent contributions for the erection of the institution, subject to an undertaking by the London County Council to maintain it at a cost of £20,000 annually. An admirable site is to be placed at the disposal of the trustees by the Royal Commissioners of the Exhibition of 1851, adjoining the present buildings of the University of London, at South Kensington. Altogether, some £500,000 will thus be represented. Lord Rosebery, as the chairman of the trustees, will be assisted by the Duke of Devonshire, Mr. Balfour, Sir Francis Mowatt, Mr. Julius Wernher, Mr. Haldane, and others.

As we go to press it is our pleasing duty to record the fact that, subject to certain safeguarding conditions, the London County Council has fallen into line with the proposal. High appreciation of the offer is expressed, and it is pointed out that the project "will put, as it were, the crown upon the systematic organisation of technical education which the Council has, for the past ten years, been carrying out. There is no intention of overlapping or duplicating any of the existing agencies, and in the arrangements the importance of co-ordinating all the higher educational work in London, in close connection with the University, will be a fundamental consideration. It is claimed that, after allowing for fees, the maintenance will greatly exceed £20,000 annually; but, on the other hand, the donors hope to receive help from private individuals in subscriptions and permanent endowment and substantial assistance from the Government.

The work to be performed by the new institution is ably summed up by the *Times*: "Its organisation has not, of course, been determined in detail, but, unlike the German technical high schools, which in their present development stand outside the Universities, and are practically self-governing Universities themselves, it is to be organised as a school of the University of London. The arrangements are to be worked out in consultation with the Senate of that corporation, of which Lord Rosebery is the Chancellor. Other bodies concerned are also to be taken into counsel, and while the new 'school' will constitute a separate and distinct entity within the University, under the management of a committee of its own, it is intended to work in close co-operation with the Royal College of Science, the Central Technical College, and other branches of the University engaged in work of a somewhat similar kind. It is designed to train 'the skilled lieutenants and confidential assistants' of our captains of industry, and therefore to meet the wants of advanced students, and of advanced students only, like the German high schools, and it will afford facilities—so sorely needed in this country—for original research.

It will not overlap the work of other bodies, but will endeavour to supplement it by taking up subjects, such as chemical technology, mining and metallurgy, electro-chemistry, electric traction, railway and marine engineering, naval architecture, and others, which are at present ignored or dealt with in a perfunctory and unsystematic way. The education it provides will be brought within the reach of relatively poor men by low fees and scholarships. It desires to open its doors to the best brains of the Empire which are devoted in the future to that 'conversion of general scientific knowledge into scientific values,' which has been in so large a measure the foundation of the industrial greatness of our most formidable rivals. Our eminence in practical activities is still maintained. We have now to supplement it with a thorough appreciation of the relations of science to the work those activities are directed to achieve, in order to face with equanimity the efforts of all our competitors. The new institution offers us the means to do so."

The Bessemer Memorial.

By a somewhat singular coincidence, the promoters of the Bessemer Memorial launched their scheme at almost the same time, but, as Mr. Haldane pointed out, there will be no clashing between the two schemes, the one, indeed, being an integral part of the other. As Mr. Andrew Carnegie remarked on a recent occasion, there is a wide field for surplus wealth in the direction of scholarships "That results should have followed so fast upon the gift that he made to the Iron and Steel Institute seemed to him miraculous." The true influence of scholarships upon the race can never be entirely appraised, and as a memorial they have certainly a more lasting endurance than the finest monument of bronze or stone. It is interesting to note, therefore, that the promoters of the proposed Bessemer Memorial have in contemplation a proposal of a thoroughly practical kind. The primary aim will be the thorough technical instruction of mining and metallurgical students. Metallurgical tests and research of all kinds, for which facilities are not available in Birmingham or Sheffield, will be carried out on a practical scale. In this way advanced students will be afforded opportunities for the acquirement of practical knowledge and for original research which it would be difficult to obtain in any other way. The second object of the memorial will be a system of grants, in the form of scholarships, for post-graduate courses in specialised practical work in London and the great metallurgical centres. Sir William Preece has accepted the chairmanship of the committee, and at the meeting which was held to inaugurate the fund, the Lord Mayor (Sir Marcus Samuel), paid a graceful tribute to the memory of the late Sir Henry Bessemer, as probably one of the greatest men who ever lived. On the motion of the Duke of Norfolk the following resolution was unanimously carried: "That this representative meeting heartily endorses the proposal to commemorate the great achievements of the late Sir Henry Bessemer, the inventor of the metallurgical process which bears his name, and it strongly affirms that such commemoration should have for its object some educational work as far-reaching in its beneficent influence as are the results of Bessemer's great invention." On the motion of Mr. Haldane, K.C., M.P., a resolution was carried approving the proposals as above outlined. In the course of his remarks he showed the relationship which will exist between the Bessemer Memorial and the Rosebery scheme. "We possessed," he said, "magnificent energy, we had a splendid record; but in the application of science to industry we had not hitherto developed anything comparable to those great institutions for technical training in the highest sense such as existed across the German Ocean. What they were now dealing with was a separate matter, but the two schemes were closely allied, because the proposition was that the work which was to be done in teaching by the Bessemer Foundation should form a part—an integral part—of the larger scheme for raising the nation's efficiency. The scheme for a memorial to Bessemer was of the same character as the larger scheme, but it was directed to those special industries with which Bessemer's name was immediately associated. He had reason to know that His Majesty the King was fully cognisant of the details of the great scheme which was laid before the public in Lord Rosebery's letter, and that His Majesty had also been informed of the proposal to launch the Bessemer Memorial scheme in connection with and as an integral part of it; and he had the highest authority for conveying to the meeting his belief that the King viewed the entire scheme, including that which they had been discussing that afternoon, with favour." "Bessemer" is certainly a name to conjure with throughout the civilised world, and the scheme thus launched under such highly favourable auspices cannot fail to meet with wide support.

The Civil and Mechanical Engineers.

By the courtesy of Mr. Callaway (General Manager), Messrs. Thorneycroft and Co.'s torpedo boat works were, on the 10th ult., thrown open for the inspection of the members of the Civil and Mechanical Engineers' Society. Of this privilege a fair number of members availed themselves, and a very instructive afternoon was spent under the guidance of four cicerones, who were told off to do the honours of the occasion. Several departments, notably, the foundry and the sail-making depôt, had already closed for the day, but considerable time was occupied in making a tour of the extensive premises, and the visitors had an opportunity of boarding H.M.S. *Kennet* and *Jed*—two torpedo-boat destroyers, which were commenced about eight months ago, and will be complete early in 1904—while, on the river alongside was a newly completed gunboat destined for work on Chinese rivers, and built to the order of the Japanese Government. If one thing more than another impressed us it was perhaps the extraordinary number and variety of machine tools employed in the works, many being operated entirely by unskilled labour. In this direction the firm shows every indication of progressiveness ; in fact, during our visit we noticed one of the very latest American lathes, which was waiting on a siding to be unpacked. There can be no question but that in arranging these visits of inspection the Civil and Mechanical Engineers' Societ yis doing a sound practical work.

Alternate Courses in Engineering Training.

The new Principal of King's College, London—Dr. Arthur C. Headlam—announces that the Council of the College has taken a step which (if certain support is obtained) will bring into vogue at the College alternate courses of school and workshop training on the lines suggested by Mr. Yarrow. The engineer and science professors of King's College have had this new proposal under consideration, and have drafted a scheme which deserves, as Mr. Headlam says, a great measure of public support. "The three years' college course for mechanical and electrical engineers will be extended to four years, and will last through the six winter months, the six summer months being spent in the engineering factories and workshops. Through the interest taken in the scheme by Mr. Yarrow, a number of engineering firms have been found to co-operate with it, and if financial support—comparatively speaking, small in amount—can be obtained, it will be started in October."

Mr. Headlam further remarks that it must unfortunately be some years before the technological institute, outlined by Lord Rosebery, can be ready for work, and, especially at first, its success will largely depend on the existence of a considerable number of trained students to assist in its work and take advantage of its facilities for higher teaching ; while in the future, owing to the fact that the institute is to be devoted to research and post-graduate studies, it will require the vigorous co-operation of all the engineering schools, and especially of those of University and King's Colleges, which provide such a large proportion of the existing students of London University.

The Royal Agricultural Show.

In view of the fact that the sixty-fourth Annual Show of the Royal Agricultural Society was held on their new permanent show-ground at Park Royal, in close proximity to London, an exceptionally large attendance might reasonably have been anticipated. Yet the total of 65,013 visitors who paid for admission was the smallest for twenty-eight years. The greatest success the Society ever attained was at Manchester, in 1897, when 217,980 persons passed the turnstiles. The number of feet of shedding, exclusive of open ground space, allotted this year to the implement department was 14,588 ft., as compared with 11,093 ft. at Carlisle last year, and with 13,524 ft.—the average of the seven years 1896-1902. There were altogether 456 implement stands, as compared with 339 at Carlisle last year. The show was extensively patronised by Royalty, and was favoured with fine weather, but, owing to the heavy rains of the previous week, the ground was very soft, and must have been very troublesome to exhibitors of heavy machinery. Among the new implements exhibited, several improved forms of oil engines were conspicuous. Two silver medals were awarded, one going to Messrs. H. Pooley and Son, Ltd., of Birmingham, for their Simplex Automatic Grain Scale, and the other to Messrs. Ransomes, Sims, and Jeffreys, Ltd., of Ipswich, for their Hand Power Sheep-shearing Machine. As a result of the trials of wind-pumping machines, instituted by the Royal Agricultural Society, the first prize of £50 was awarded to the Goold Shapley and Muir Company, Ltd., Brantford, Ontario, the second prize of £20 going to Messrs. Thomas and Son, of 64, Broad-street, Worcester. The special features of the Canadian engine were general excellence of design, especially as regards the engine and pump ; efficiency, as determined by the quantity of water pumped ; successful governing ; the arrangement for the automatic application of the brake ; economy in upkeep, due to the slow motion of its moving parts and good workmanship ; and its reasonable price. The second prize was awarded on the strength of the generally satisfactory nature of the design of the engine and of the tower and the thoroughness of the workmanship in its execution ; the provision of an efficient brake ; the comparative economy of upkeep arising from the soundness of design, and the comparatively slow motion of the pump ; ease of putting up ; and reasonableness of price.

The heat was at times excessive, and some of the exhibitors had reason to congratulate themselves on having provided cool retreats for shelter and converse. It could not be said that a cheery optimism prevailed among those exhibitors of machinery with whom we personally came into contact, and one or two seemed to doubt whether enough grist would come to the mill to pay expenses. One exhibitor contrasted the "Royal" show with the Bath and West of England fixture, much to the advantage of the latter. We are decidedly of opinion that the superiority of the new ground from the point of view of the exhibitor of machinery remains to be proved. Generally speaking, the result of the show must have been a startling disappointment to its promoters.

AMERICAN RÉSUMÉ.

NEW YORK, July 20th, 1903.

Niagara Falls.

The following information will be interesting to lovers of unusual or remarkable figures, and will incidentally answer some questions that many have asked but few can answer, namely, how much water flows over Niagara Falls in a given time, and what is the power it represents? It has been estimated that the flow at average seasons amounts to 275,000 cubic feet per second, or 500 tons per minute, which, allowing the total fall to be considered as beginning at the upper rapids, and ending at the foot of the cascade, 216 ft., would place the theoretical available horse-power at about 6,000,000, of which not one-sixth is at present utilised.

A Volcano as a Sulphur Mine.

A current report has it that negotiations are on foot for the transfer of the title of the famous volcano, Mt. Popocatapetl, in Mexico. Its present owner, General Gasper Sanchez Ochoa, received it from the government of Mexico in recognition of certain political and military services, and is said to have offered it for sale at merely $5,000,000—a bargain, considering the millions of dollars worth of sulphur it contains. Two parties are declared to be bidding for it, one backed by John D. Rockefeller, and the other by John P. and Samuel Green, of Pittsburg. There are two schemes by which it is proposed to work the sulphur mine; one is to tunnel into the volcano at about 600 yards below the crater and to remove the sulphur by a mechanical agent in the form of a cable conveyor consisting of a 1-in. steel cable carrying buckets 100 ft. apart. These will dip into the red hot molten sulphur and bring it out, the buckets travelling at the rate of 200 ft. per minute. The estimated cost of this equipment is about $500,000. The other scheme proposes to send a cogwheel railway over the lip of the crater directly down into the sulphur lake, but it is questionable if sufficient foundation is available to sustain the heavy supporting members that would be necessary. For many generations this sulphur has been mined in a crude fashion, and it is believed to be inexhaustible, as it is apparently replenished as fast as it is removed. Its market price at present is $40 per ton, but there is no danger of the price falling by over-production at this source, if the rumoured speculators acquire the mountain.

Some Big Dividends.

The increasing popularity of the mineral industry among speculators may be directly attributed to the large dividends which are being paid in these days. The gain in profits is partly the result of economical improvements in the processes for treating low grade ores, and partly the result of more careful management, especially in companies heavily capitalised, but it is chiefly due to the greater demand for the products. Forty-eight mining and metallurgical concerns in the United States paid dividends in May amounting to $13,549,228, the second best record for this year, and a greater one than was reported for May, 1902; $8,929,919, or over 65 per cent. of this amount was the quarterly dividend of 1·75 per cent. paid to the holders of preferred stock in the United States Steel Corporation, of which there are some 31,799. For business reasons this company is now retiring part of its 7 per cent. preferred stock by the issue of 5 per cent. bonds. The Amalgamated Copper Company paid the second largest dividend this month, when it declared 5 per cent., or $769,430 quarterly, which is equivalent to 25 per cent. of the total payments by metal mines. Mexican mines and metallurgical works in which many Americans are interested are also making good reports. Eleven of these paid a May dividend amounting to $243,630, and two Central American properties, $51,000.

The Fate of the Ferris Wheel.

The Ferris Wheel, which will be remembered by those who visited the World's Columbian Exposition, at Chicago, in 1893, as one of the curiosities of the Fair, has been purchased by the Chicago House-Wrecking Company for the absurdly small figure of $2,000. Such is the final disposition of a work that originally cost $362,000, and was regarded as a most wonderful piece of engineering construction. Since the close of the Exposition it has occupied a plot of ground in the northern part of Chicago known as Ferris Wheel Park, but it soon ceased to be a paying concern after the novelty wore off. The new owners have not declared their intentions as to what they will do with the wheel, but even as old iron they have secured a bargain.

A Solid Steel Car Wheel.

Mr. Charles T. Schoen, of Bethlehem, Pa., has recently perfected a new process for making railway car wheels of solid steel by rolling and forging. These are claimed to be much superior to wheels with cast-iron bodies and steel tires, as now commonly made for passenger coaches, and at the same time the cost is less. The process commences with the casting of a steel ingot, 24 in. in diameter, which as soon as it solidifies is placed under a double-acting hydraulic press, and forged until the diameter is increased to about 28 in., by reducing the thickness of the web. This press stands 45 ft. high, and can exert a pressure of 5,000 tons. While still hot the blank is placed in an enormous rolling machine, and worked between six rolls to the finished diameter of 33 in. The rolling mill occupies a floor space of 22 ft. by 40 ft., and the rolls are driven by a pair of 1,000 h.p. reversible engines, while three electric motors drive the six-feed rolls, the latter being arranged to operate singly or in combination. When the proper diameter and thickness of the wheel has been obtained the notors are cut out automatically. After rolling, the finishing touches are put on in another powerful hydraulic press, where the ends of the hub are faced and the rim aligned with the hub. The whole process is completed in one heat, and takes about four minutes. The wheels weigh between 600 and 625 lbs., and are characterised by an unusually thick rim which will allow them to be worn or turned down 1¾ in. before they must be discarded. Among its advantages over the all cast iron wheel or the steel-tired wheel are greater strength, less danger from becoming heated, as it never cracks and never loses its tire; less expensive machine work, and no defective material; and a cost of production which, though a third greater than the all cast iron wheel, on account of the material used, is more than offset by the increased length of life and safety, and the decreased weight of the wheel. It is said to cost half as much as a steel-tired wheel.

GERMAN RÉSUMÉ.

BERLIN, July 20th, 1903.

Conference of the Institution of German Electrical Engineers.

At the eleventh annual conference of the above Institution, held in Mannheim, the chairman, Prof. Ulbricht, reviewed the development of electrical engineering in Germany during last year. Though, on account of the commercial depression, industrial advancement was but slow, many scientific and technical improvements were to be recorded. It was gratifying that leading men, at a time when the pressure of business was somewhat relaxed, had devoted themselves to investigating new problems, thus preparing the path of future industrial progress. As regards the most important advances made in the province of low tension currents, there might be mentioned the experiments carried out in connection with the problem of long distance telephonic transmissions, a more extensive use of telephones in railway service, the laying out of the first German transatlantic telegraph cable, as begun a few weeks ago, from Emden, and finally, some new methods of tuning in wireless telegraphy. Many advances had also been made in connection with high tension currents. By compensating and compounding synchronous machines, the facilities of application of the latter had been greatly increased, whereas the use of polyphase currents of different frequencies in the same line seemed likely to admit of long distance power transmissions being utilised in a more economical way. As regards electric railways, very promising schemes, using monophase current had been suggested. The advancements made in connection with large steam turbines were likely to admit of a more economical utilisation of the space available in the equipment of central stations. Electric lighting had been greatly improved, new lamp systems being designed, and electric lamps adapted for the lighting of railway cars on an extensive scale. Progress had also been made in electro-chemical research, more especially in the direction of fixing the nitrogen of the air in a form available for agricultural purposes.

Forty-fourth General Meeting of the Institution of German Engineers.

At the forty-fourth general meeting of the *Verein Deutscher Ingenieure*, held on June 30th and July 2nd (in Munich and Augsburg), one of the most important papers was contributed by Prof. Ostwald, the well-known physico-chemist, who dealt with the relations between engineering science and chemistry. Incidentally, he remarked that the work accomplished by students of thermo-dynamics and theoretical chemistry in connection with the engineer must of necessity bring about excellent results in the gasification of fuel. A rational gasification of peat with minimum losses of energy and at low temperatures would thus prove of the greatest importance. The action of water vapour on ardent coal, resulting in the production of either carbon monoxide or dioxide, according to temperature, might be modified in any desired way by men of thorough scientific training. Centralising the gasification of fuel and extending it to peat and brown coal would give rise to important developments in the industry of bye-products, the hydro-carbons, as bye-products of gasification, becoming a valuable substitute for petroleum. As, moreover, all fuel included several per cent. of fixed nitrogen, central gasification would afford a means of reducing atmospheric nitrogen to a form immediately available in agriculture. Nor would the manufacture of gunpowder be any more dependent on the import of Chili-saltpetre. The ammonia of gas-water might be directly converted into nitric acid (after the author's own method), agriculturists thus being enabled to use ammonium nitrate including 35 per cent. of nitrogen, instead of sodium nitrate with only 25 per cent. of this element.

Finally, the author discussed the problem of scientific and technical education, pointing out that universities and technical high schools, though incapable of being fused together, should aim at the same final purposes, so as to become united in future by common work. In order to arrive at this result, the principle of free scientific work should be universally acknowledged. The author suggested the creation of a scientific technical research department in connection with the Institution of German Engineers.

Fuel and Efficiency.

Another interesting paper was by Prof. von Linde The author discussed, by the aid of rather instructive work and heat diagrams the important question as to what amount of mechanical work may be derived from a unit of fuel with the different systems of power engines. In the steam engine the utilisation of the heat gradient and the distribution of the heat derived from the fuel were so unfavourable that only 13·8 per cent. of the total amount of energy contained in the fuel was gained as indicated efficiency. Using superheated steam would allow of this percentage being increased up to 16·6 per cent. Locomotives working without condensation would even exhibit a thermic efficiency as low as 8·8 per cent., in the case of a tension of steam 13 atmospheres and a high super-heating being used. An efficiency materially higher was obtained with exhaust heat engines, as developed by Prof. Josse, whose system converted 15·6 per cent. of the heat contained in the fuel into mechanical work. Parson's steam turbine worked under conditions nearly as favourable, and secured an improvement of the efficiency equal to 1 per cent. for every 6 to 7 deg. C. of superheating. The first 2,500 kilowatts steam turbine installed in the Frankfort Electricity Works worked at a superheating as high as 300 degrees with an efficiency of 15·3 per cent. of the amount of heat contained in the fuel. Utilising in a uniform way the whole of the temperature gradient would afford the means of reaching a consumption of steam as low as 6·35 kilogrammes per kilowatt. The combination of a reciprocating steam engine and a steam turbine, as recently made in Paris, had confirmed the theoretical distribution of heat. Further advantages would be obtained by combining a high heat engine, a steam engine, and an exhaust heat engine, though an efficiency higher than about one-sixth of the energy contained in the fuel would be impossible with steam engines on account of natural laws. Better results might be obtained by the use of combustion engines, the first of which was the atmospherical gas engine that created such sensation at the 1867 Paris World Fair. Otto's gas power engine then came with its notable success, though that system was not able to afford a substitute for high power steam engines. Dowson, Renier, and others meanwhile greatly improved the gasification devices for anthracite and coal, so as to make the amount of heat contained in the gases produced much higher than that of boiler steam. The Deutz Gas Motor Manufacturing Company recently succeeded in gasifying in one generator a large variety of bituminous fuels. Large gas engines were therefore now in many cases a rational substitute for great steam engines. A new principle had been introduced seven years ago into the construction of heat engines by Diesel, the compression of the air of combustion being highly increased, and a much more advantageous distribution of heat being secured. Besides the limits of strength of the material used in the construction of the engine, there were the limits of compression, due to the as yet unknown relations between the dissociation phenomena and the temperature and pressure; on the other hand, the compression generally used being 35 atmospheres. The new Diesel motors, built by the Augsburg Engine Manufacturing Company, gave 42 per cent. of the heating value of the liquid fuel as indicated mechanical work, this corresponding to an economical efficiency of 32 per cent. Similar results had been obtained with modern spirit-motors. Blast-furnace gas motors would work with rather inferior fuel, the Nürnberg Engine Manufacturing Company having obtained with a 750 h.p. motor 34 per cent. of the gas-heating value in the form of indicated work.

The author pointed out that in the course of the last forty years the construction of steam engines had advanced from one-tenth to one-sixth of the economical efficiency, whereas combustion engines had already reached nearly one-third. The efficiency of an engine, however, was by no means the only important factor, as simultaneous production of heat and light might be obtained. It therefore seemed that the steam engine would still retain part of its applications. Prof. von Linde finally discussed the problem of centralised utilisation of fuel in the form of work, heat, and light for all the purposes of industry and everyday life. Centralised gasification was likely to improve the conditions of living in the great cities and centres of industry, this scheme having already been suggested thirty years ago by William Siemens.

Fast Electric Traction on the Zossen Military Railway.

The company studying the problem of rapid electric traction on the Zossen military railway have now issued a record of the work so far accomplished. On account of the limited strength of the permanent way, the average speed chosen was only 125 kilometres per hour. The experiments included, measuring the resistance of motor cars at different speeds, as well as the consumption of power and current losses at different loads and speeds, making braking tests, etc. The measurement relative to the behaviour of air behind and before the carriages are particularly instructive. At the higher speeds a hill of compressed air would be observed on the front wall of the first carriage, extending as far as 4½ metres from it, the corresponding space behind the last carriage not, however, being filled with suction air. The pressure of air being the greater part of the total resistance of the cars, the external shape of the latter should be such as to diminish the resistance of air to the greatest possible extent. The shape shown to be the most suitable is a paraboloidical form as, however, the front of the cars cannot be shaped in this way, a cylindrical form of the front would seem to be the most advisable. The lateral walls do not receive any pressure, but by lateral winds, influencing the aggregate resistance in no material way. In order to diminish the front resistance, uniting the cars by bellows is the most convenient scheme.

Fast Telegraphic Service between Berlin and Konigsberg.

The German postal authorities are stated to have ordered a trial service to be made with the Pollak-Virag rapid telegraph on the line about 700 kilometres in length, between Berlin and Königsberg. The apparatus located at the Charlottenburg Technical High School works on an artificial line, 500 kilometres in length, so as to allow of 50,000 words per hour being easily transmitted in readable writing, this output being, however, liable to be further increased. Telegrams are transmitted to the sending apparatus in the form of perforated strips of paper, such as anyone may easily prepare himself on a special writing machine, this strip being drawn at a very high speed over contact rollers and metallic brushes. As the latter comes in contact with the roller at the perforated places, the current will be completed an enormous number of times, causing the membranes of two telephones placed at the receiving station to vibrate, the oscillations producing combined movements of a mirror. The latter will record the despatch graphically by means of the reflex of a luminous point. It is anticipated that the above experiment will establish the practical conditions most suitable for a similar rapid service.

SOME RECENT PUBLICATIONS.

"A TREATISE ON MINE SURVEYING."

By Bennett H. Brough. (Tenth edition.) With numerous diagrams. London: Charles Griffin and Co., Ltd. 372 pp. 7s. 6d.

WE have to congratulate the author of this work on the issue of still another edition. Few technical treatises have attained to the dignity of ten editions, and the fact that a work, the subject of which interests a comparatively limited circle of readers, has done so, is the best criterion of its value as a standard work of reference on mine surveying. Originally published in 1888 as an aid to his students when the author was lecturer on mine surveying at the Royal School of Mines, each successive edition has been revised and enlarged. In its present form the book is divided into twenty chapters. In the first the author gives some general explanations. He dwells on the importance of mine surveying, and certainly does not exaggerate it. Instances could be multiplied showing the danger to life and the loss of valuable mineral owing to inaccurate plans. The second chapter deals with the measurement of distances, and the four chapters which follow are devoted to surveying with the miners' dial. The various forms are described, and useful information is given regarding sources of error with the magnetic needle. The quaint old German dial, which still has a limited field of usefulness, has a chapter devoted to it; and the three following chapters deal with the mine surveyor's most valuable aid, the theodolite, and its use underground and at the surface. The remainder of the volume is devoted to the calculation of areas, levelling, the connection of the underground and surface surveys, measuring distances by telescope, setting-out, mine surveying problems, mine plans, the application of the magnetic needle in mining, and photographic surveying. There is an appendix containing typical recent examination questions, and another includes a carefully compiled bibliography of the subject.

Since the first edition of this work was published fifteen years ago, there has been a marked improvement in mine surveying practice, and Mr. Brough certainly deserves great praise for having brought Continental methods to the notice of English readers.

We notice that in the present edition the author describes Sir Howard Grubb's new sight for mining dials, the Dunbar-Scott mine tacheometer, the setting out of the Simplon tunnel, and the difficulties encountered in plumbing the very deep shafts at the Tamarack mine on Lake Superior. We should like to have seen included some particulars regarding the determination of positions by astronomical methods, and the elements of nautical astronomy for the use of explorers. These are matters that the mine surveyor in the Colonies is often called upon to deal with.

"SUBMARINE NAVIGATION PAST AND PRESENT."

By Alan H. Burgoyne, F.R.G.S. Two Volumes. Illustrated. Grant Richards. 31s. 6d. net.

MR. BURGOYNE, in these two handsome volumes, deals with an attractive subject in an attractive manner, many excellent plates and illustrations being scattered throughout the work, which to some extent tell their own tale. Despite the wide difference of opinion as to the merits of the submarine as an effective unit in modern warfare, its importance is unquestioned, and, as the author very properly remarks, to ignore it altogether is a procedure not only foolish but also in time likely to be fatal, for "the submarine boat *has arrived* and what is more, will remain, improving as time goes on and as science places new powers and inventions in the hands of engineers." The author first gives, as much in detail as possible, a history of submarine navigation from its commencement to the present time, afterwards proceeding to discuss the utility of the submarine in modern warfare, and to give some account of the theory of the question. All the leading types are carefully described, perhaps the most interesting account being that of Mr. Lake's wonderful submarine as described, some time ago, in PAGE'S MAGAZINE. The amount of inventiveness expended upon submarine vessels since the first was constructed by Cornelius Van Drebel, is astonishing. Good, bad, indifferent, and altogether impossible ideas are chronicled by Mr. Burgoyne with absolute impartiality. We never heard or read anything about James I., that would induce us to credit the statement that that timid monarch once descended in one of Van Drebel's boats and remained under water between three and four hours. The author, however, thinks there is no reason to doubt it. He tells again the ghastly story of the attack on the *Housatonic* by the "David" submarine in the American Civil War, when the submarine became fixed in a hole in the side of the ship which it had itself created and was dragged down, its crew of nine being "drowned like rats." The second volume, which deals largely with the theory of the submarine, has a large section devoted to the "Holland" boats, and its frontispiece is a portrait of their inventor. The author's ideas on the subject of submarine navigation will be read with an added interest in view of the fact that he has himself invented a submersible boat, and there are a great number of valuable opinions about submarines by naval officers and others, which form a valuable record. We have nothing but praise for the design and execution of this work, which is a timely addition to the somewhat scanty literature of the subject.

"THE DEVELOPMENT OF THE LOCOMOTIVE: A POPULAR HISTORY, 1803-1903."

By Clement E. Stretton, Mem. Soc. Eng. 6th Edition, revised and enlarged. Crosby, Lockwood and Son. 270 pp. 4s. 6d.

MR. STRETTON has long been favourably known as an enthusiast in all matters connected with railways, and also as an able and "informing" writer on such subjects. The book under notice, appears to bear the alternative title of "The Locomotive and its Development," and is now purely on the strength of its intrinsic merits, in the honourable stage of a sixth edition, in which it is brought up to date by means of an additional chapter, and by the inclusion of several fresh illustrations, among these being the "King Edward" class of London and North-Western four-cylinder compounds; the London and South-Western four-cylinder non-compounds; the Great Northern four-cylinder non-compound, No. 271; the London and York "Atlantic," or "1,400" class; the North-Eastern six-coupled bogie express, "2,111" class; the Midland three-cylinder compound express, No. 2,632; and the Caledonian eight-coupled mineral engine, class "600." These give a very good idea of the more recent developments in British locomotive practice. Mr. Stretton styles his book "A Popular History," and this character is well-sustained, for he relates in pleasant style the history of the locomotive from its virtual inception by Trevithick, just one hundred years ago, up to the most recent productions that may be seen on the metals in 1903. The value of the book is enhanced by the explanation which the author gives in general terms without burdening his pages with too many technicalities of the leading phase in locomotive construction, the various improvements that have taken place from time to time, and some of the results attained. As a popular work on the locomotive engine, Mr. Stretton's book takes a high place. It is, perhaps, to be regretted that opportunity was not taken to correct a few slips which occurred in a former edition, if only by means of an errata note, but, in any case, they are not of a serious nature, and the new edition of the book is sure to find, like its predecessors, a large circle of readers.

"THE MINING MANUAL FOR 1903."

By Walter R. Skinner, 11 and 12, Clement's Lane, Lombard Street, E.C. 21s.

THIS remarkably complete and useful work of reference, covering every section of the mining industry, has now reached its seventeenth issue. The author is to be congratulated on the vast amount of information which he is able to place before the mining public in readily accessible form. This is again classified in four sections—Australasian, South African, West African, and Miscellaneous, covering 1,341 pages. The present issue contains particulars of 3,534 companies, of which 612 are Australasian, 974 South African, 386 West African, and 1,562 Miscellaneous. As in previous issues, alphabetical lists of Mining Directors and Secretaries, and a Dictionary of Mining Terms, are included. To these a list has been added of Engineers and Mine Managers, giving the names of the companies with which they are connected. Tables of individual crushings of South African, Australasian and Indian mines, will be found in the various sections in which the companies are dealt with. In dealing with these figures the yield per ton of ore is included for the first time. An appendix is devoted to the latest registrations of new companies, and other information completing the particulars up to within a few days of the issue of the work. A word should be said in praise of the index, which helps in no small degree to render the Mining Manual a most useful addition to the reference library.

"LATHES, SCREW MACHINES, BORING AND TURNING MILLS."

By Thomas R. Shaw. With 425 illustrations. Scientific Publishing Co., Manchester. 15s. net.

THE moral underlying the observations with which Mr. Shaw prefaces his interesting volume is abundantly clear—do not spend hours on elaborating a new idea until you have determined accurately what has been accomplished in the past. In designing new machine tools, the ground is cleared by exact knowledge of what has been settled by experience, and the student will here find a fairly comprehensive view of the whole subject. The author devotes a considerable section of the work to the various forms of lathes, remarking that the mechanic, when complete master of that appliance as used in general work, will have learned nearly all the particulars involved in operating other classes of machinery. The remainder of the volume is devoted to screw machine, boring and turning mills, and their accessories, and we note that a companion volume will be devoted to planing machines, milling machines, etc. The pictorial element in a volume of this kind has a largely enhanced value, and the author has wisely included many half-tone and line illustrations representative of the best and most up-to-date practice. In his general notes on design Mr. Shaw speaks in no uncertain terms of the evils arising from the policy of closed doors adopted by certain English firms in connection with the use of labour-saving tools, remarking that "the interchange of ideas which has been so prevalent among the more progressive shops of America, is one of the important factors which to-day make her so serious a rival in the machine-tool building trade." The shop manager or proprietor who does not assimilate new ideas from outside sources, and thereby improve his practice, will surely fall behind, unless he be of extraordinary ingenuity and possessed of great mental resources. The collapse of several old-established firms—whose name alone should ensure their success—is entirely due to the absence of up-to-date methods of production; and, undoubtedly, one of the reasons why so many English firms are behindhand is the policy of closed doors and secrecy that is adopted, and the prejudice as compared with the American practice.

"TELEPHONE LINES AND METHODS OF CONSTRUCTING THEM OVERHEAD AND UNDERGROUND."

By Walter C. Owen. With 265 illustrations. Whittaker and Co. 5s.

THE writer, a telephone manager and engineer of twenty years' practical experience, has succeeded in compressing into handy form much useful information which ought to be in the hands of the rank and file of telephone employees, and at the same time by the avoidance of too technical phraseology, has rendered the subject attractive to those who are approaching it for the first time.

"BLACKIE'S SHILLING DICTIONARY."

444 pp. 8vo. Blackie and Son, Ltd.

IN an age when new words are daily being coined and added to the English language, the task of producing a dictionary in handy form suitable for general use, is one of very considerable difficulty. We have put this dictionary to one or two tests from which it has emerged satisfactorily. Of course not until the millennium will a dictionary be produced that will give us just what we want, and refrain from giving us things we do not want. If we expect Blackie to give us the meaning of "aetheric telegraphy," "cinematograph" or "gramaphone," we shall go away disappointed, but he will tell us all about "leze-majesty," "puppyism," and other things that we may or may not require. Probably nine-tenths of the users of dictionaries consult them on the spur of the moment to lighten the burdens of etymology. They are apt to overlook the appendices provided by the beneficent publisher. These in Blackie's Shilling Dictionary, form a somewhat remarkable feature, including terms and measures used in physics, engineering, etc., mechanical movements pictorially illustrated, and several other useful sections. The dictionary is clearly printed, and we have given it a place among our reference books.

NOTABLE BRITISH PAPERS OF THE MONTH.

A Monthly Review of the leading Papers read before the various Engineering and Technical Institutions of Great Britain.

ELECTRIC WIRING AND FIRE RISKS.

A VALUABLE paper on this subject was contributed to the International Fire Prevention Congress, by Mr. E. C. de Segundo, in the section devoted to "Electrical Safeguards and Fire Alarms." In the course of his paper the author remarked that:—

The essential condition of a properly erected wiring installation consisted in providing that the electric current should be kept within the prescribed bounds, and that if by any unforeseen contingency a way should be opened for the current to travel in any unauthorised direction the supply should be cut off automatically and instantly. No absolutely trustworthy means had as yet been devised whereby possible trouble due to electricity "out of bounds" could be guarded against, and the efforts of those who were working in the cause of fire prevention should be directed towards bringing about the adoption of the best kind of insulation and the most suitable kind of mechanical protection for the wires. For safety against risk of fire one must depend entirely upon the means adopted for keeping the electric current within its designed sphere of action—namely, the character of the insulation of the wires or the means adopted to prevent contact between wires of opposite polarity. This included the insulation on the wire and the means adopted to guard against mechanical injury and damp. Up to the present nothing had been found to touch best quality rubber specially prepared to resist the oxidising action of the atmosphere, and the deleterious influence of any rise in temperature of the conductor. It was possible, however, that before long a new form of insulator might be introduced upon the English market, which, while possessing all the useful properties of gutta-percha, was practically indifferent to the action of light and air, and was very much harder than gutta-percha. Large quantities of wires insulated with this material had already been used on the Continent with excellent results. The ideal method of wiring a building, in his opinion, was to use nothing but the highest class of vulcanised or other suitable rubber insulation with some suitable form of mechanical protection in the way of braiding, and to enclose the wires in a continuous system of cold drawn steel tubes specially selected for smoothness of bore, with joint boxes inserted at all points necessary to enable the drawing in of the wires to be carried out without injury to their protective covering, and to facilitate inspection, withdrawal of any wires for the purpose, if need be, of increasing their size, etc., the whole system of steel tube and joint boxes being connected to earth.

FAST COALING SHIPS FOR OUR NAVY.

AT the summer meeting of the Institution of Naval Architects, an important paper on the above subject was read by Mr. E. H. Tennyson D'Eyncourt. The paper was more particularly concerned with the provision of specially designed fast coaling vessels to accompany our squadrons when travelling at a high rate of speed, and so supply them with fuel without any delay. In the course of the paper Mr. D'Eyncourt said:—

I may be blamed, as a mere naval architect, for introducing what must necessarily be, to a large extent, a question for the naval authority and the strategist; but my excuse is, that naval architects have to consider the question of vessels keeping the sea for long periods, their radius of action, and kindred considerations, in the initial stages of a design, questions which are inseparably bound up with others coming within the province of the tactician and strategist. It is, at any

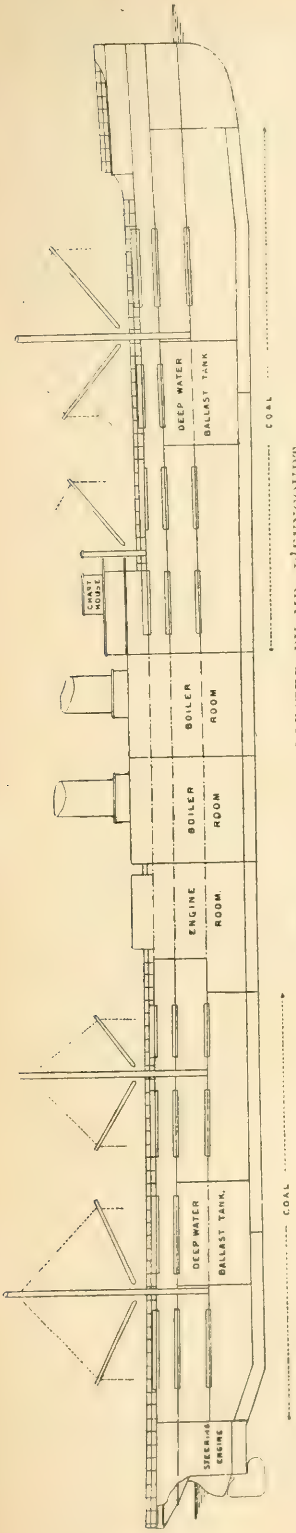

FIG. I. FAST COALING VESSEL SUGGESTED BY MR. D'EYNCOURT.

rate, the business of the naval architect to say what kind of ship can be provided for any special object, and, when the type has been approved, to endeavour to produce the best possible article to fulfil the required purpose.

The Government has no doubt considered the question of building some such vessels as I propose, and some barges have actually been built, which can be towed about and have all the necessary appliances for dealing expeditiously with a cargo of coal; these barges carry about 1,000 tons. Some much larger vessels of a similar character, but with a capacity of about 10,000 tons of coal are, I believe, now under construction; these vessels, however, like the smaller barges, or "coal haulabouts" as they are termed, have no means of propelling themselves, and can only be moved about very slowly by towing.

Both the above-named types of vessel will doubtless prove exceedingly useful, and will help to hasten the process of coaling our warships, in the close neighbourhood of the coaling station or depot to which they belong. But though in this way they may prove of great service, these coal haulabouts lack that vital necessity in time of war—mobility.

It therefore appears essential that our Navy should possess a sufficient number of vessels with all modern appliances, such as Temperley transporters, for quickly dealing with coal, both in harbour, when taking it on board, and at sea, when discharging it into warships alongside; and that these vessels should also be able to keep up with a fleet—not perhaps with our fastest cruisers at full speed (for to accomplish this and to carry a good cargo of coal is well nigh impossible except by going to very large and costly ships), but certainly to keep up with our most modern armourclads, that is, to be capable of maintaining a sea speed of 17 knots, and to do 18 knots in case of an emergency. If we can achieve this a great deal will have been done towards increasing the efficiency of our Navy, and we shall find that it can be done at a cost which is small when set against the immense advantages which will be gained.

The high rates of speed now attained by our warships are no doubt of extreme value, but the capacity of being able to keep the sea for a long period at a good rate of speed, or, as it is usually termed, the radius of action, is certainly of equal importance. It has been customary to give the radius of action of vessels of our Navy at a very low speed, usually 10 knots. This may be very well on paper, and is no doubt good enough in times of peace, when such a slow speed has the great merit of economy, but it would never do in war time to crawl about at 10 knots if a higher rate can possibly be attained and maintained with safety, and without too great a risk of being left without coal at a distance from the nearest coaling station.

Without coal ships in attendance, when the coal is nearly used, or perhaps only half used in the case of the base being distant, the fleet must return to its base for coaling; and without fast colliers, such as are proposed, how often would the coaling ship be close at hand? We therefore may find our fleet in the condition of the inefficient army which has to return to its base for supplies every few days.

The fleet which can keep at sea for a long period will have an incalculable advantage over the one

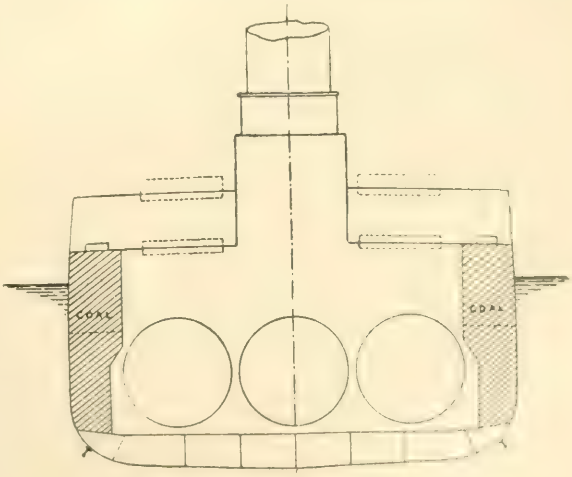

FIG. 2.

which cannot do so, and has to return frequently to coal. Our ships must necessarily return now and then for docking and cleaning and repairs, also for provisions and water unless these can be supplied them in the same way as coal, but that is no reason why the far more frequent return for coal should not be avoided if possible. It requires no great stretch of imagination to picture a naval campaign, in which the issue ultimately depended upon the fact of one of the opposing fleets being able to outlast the enemy in fuel.

The number of fast colliers that would be required must be decided by those who make the organising of naval campaigns their special care and study. However, eight of such vessels might first be tried, that is, two to each of our four most important squadrons. They should be located in pairs or larger groups at the principal coaling stations, so that whilst one of each pair is taking in coal in port, the other may be giving coal to the vessels of the squadron at a distance. They should be able to steam 17 knots easily and continuously, and 18 knots in cases of emergency, and in order to maintain a high speed in rough weather and carry a large quantity of coal (say 10,000 tons besides coal for their own use), they must be of considerable size.

The various requirements could be met by vessels of approximately the following dimensions: Length, 550 ft.; beam, 66 ft.; draught of water, 27 ft., with 10,000 tons of coal on board, so as to be able to go through the Suez Canal with full coal. On a greater draught, when there was no question of passing through the Canal, a greater quantity of coal could be carried; the amount would, however, be naturally limited by the cubic capacity of the holds. One or perhaps two deep water ballast tanks should be provided for use when in the light condition.

The horse-power necessary for 17 knots at sea would be about 12,000. The machinery would be of the most economical type with quadruple-expansion engines and cylindrical boilers, with Howden's forced draught. They would consume less than 1½ lb. of coal per i.h.p. per hour, so that at full speed the collier could go 1,000 miles from the coaling station and back on 800 tons of coal, carrying 10,000 tons of coal to the fleet, that is, enough to coal five of our largest battleships or cruisers fully, or ten to the extent of half-full bunkers, or a larger number of smaller warships.

Any one of the large cruisers or armour-clads would take four or five days to go the 2,000 miles, would use at least 1,000 tons of coal, and would have been steaming hard all the time, arriving with dirty boilers and a tired complement of stokers, etc., and a great part of her coal already burnt. Possibly 1,000 miles from a coaling station is a long way to assume, but the same thing is true for a shorter distance, only not to such a marked extent.

The coal for the collier's own use could be carried in wing bunkers, so disposed as to give good protection to the engines and boilers as long as the coal lasted.

In times of peace the colliers could be used with economy for taking coal to the coaling stations, and at the Naval manœuvres they could attend on the fleets as in war time. They would be made as little conspicuous as possible, so as not to attract the notice of the enemy.

The cost of each of these colliers, fully equipped with Temperley transporters and all the necessaries for quick coaling, would be about £270,000, so that four or five could be had for the cost of one first-class armourclad or cruiser, and the four could be kept in commission for about the cost of keeping an armourclad.

In time of war each would be an asset equal to several additional warships, as they would enable so many warships to remain at sea, saving them the time of going to and fro for coal, and giving them time to clean their boilers, do minor repairs to the engines, etc., besides resting the whole crew, officers and men.

It would, no doubt, be possible to make such colliers suitable for carrying troops, fresh water, and consumable stores, provisions, etc., other than coal; but to attempt this would to some extent spoil them as colliers, and these duties could well be carried on by other mercantile vessels, as the warships would probably not require these other commodities nearly so frequently as coal. It would, therefore, be a mistake to reduce the efficiency of the colliers in the least degree by trying to fit them for other purposes as well.

The small sketch plan (fig. 1) shows the general features of the vessel proposed. Temperley transporters would be carried on the derricks, and there would be a double set of hatches, one on each side of the vessel, so that two warships could be coaled quite independently at the same time, one lying on each side of the collier. I have shown a mercantile stern with sham rudder above water, the real rudder and steering gear being below water, and thus fairly well protected. The two water-ballast tanks would each be divided by a centre line bulkhead, and would altogether hold about 4,000 tons of water ballast.

TRAVERSING WINDING ENGINE FOR DEEP SHAFTS.

At a meeting of the Institution of Mining and Metallurgy, following the paper contributed by Mr. MacDermott on "Hoisting from Deep Shafts" (Whiting hoist), and that by Mr. Behr on "Winding Plants for Great Depths," Mr. H. M. Morgans brought to the notice of the Institution a type of winding engine invented and designed for great depths by the late Mr. Wm. Morgans. The following is an abstract:—

The object of this invention is to supply a relatively cheap machine capable of raising materials economically, conveniently, and speedily through shafts of great depth. Its essential features are as follow:—

(*a*) The use of a drum of small diameter, but of comparatively great width or length between flanges, on which to coil the long ropes without overlapping. (*b*) The avoidance of the usual "angularity" or obliquity of direction of ropes between drum and sheave wheel consequent upon the use of a wide drum. This is effected by making the drum travel parallel to its axis as one rope coils on and the other coils off; the amount of travel per revolution is made equal to the diameter of the rope, plus a trifle for clearance.

The motive force to be employed, whether electricity, steam, compressed air or otherwise is a matter of choice, and so is its mode of application, whether direct or by gearing.

In order to bring out the salient features of this winder the author describes a winding engine built by Messrs. Holman Brothers, of Camborne, from the inventor's designs, that is now installed at the Williams shaft, Dolcoath Mine, Camborne.

This shaft is intended to be sunk to a depth of 1,000 yards. The winding engine referred to is at present being used as a sinking engine with one rope only. Eventually when the shaft reaches its full depth the engine will be adapted as a permanent winder in a manner described later.

The drum is cylindrical. It is 10 ft. in diameter and 21 ft. wide between flanges. It is mounted on a crank shaft 29 ft. 9 in. long, 1 ft. 2 in. in diameter at ends of drum and increased by two steps to 1 ft. 4 in. diameter at midwidth of drum. Upon this shaft are keyed two drum end centre pieces with combined brake treads and four intermediate centre pieces. The lagging, which is formed of strips of Australian karri wood, 21 ft. long by 6 in. wide and 6 in. deep, is bolted to the centre pieces and also to non-collapsible rings that are situate half-way between each pair of centre pieces. Post brakes are fitted one at each end of drum.

Close to each drum end and outside of the drum a space is left on the crank shaft for a worm. Next come the journals, which are 11 in. in diameter by 16 in. long, and beyond these a disc crank is fixed at each end of the shaft for the connecting rods from two ordinary horizontal cylinders. The distance between centres of cylinders is 30 ft. 3 in.

The cranks are set at right angles as usual, and there is nothing calling for special comment in the construction of the cylinders, pistons, connecting rods, guides, cast-iron beds, etc. The valve gear chosen is of the Cornish double beat type, but obviously any kind would be applicable at will.

THE CARRIAGE, ETC.

The author proceeds to describe the mounting of the beds, with cylinders, gear, crankshaft, and drum complete, upon a movable carriage capable of travelling in a direction parallel to the axis of the drum and the means adopted to make it travel, and also the method of supplying steam to the cylinders.

The carriage is of simple construction consisting of built up girders. It is mounted on 20-flanged railway wheels 3 ft. in diameter, over treads which run, 10 each, on two railway tracks of 4 ft. 8½in. gauge, 57 ft. 6 in. long, having flange rails weighing 68 lb. per yard. The distance between centres of rail tracks is 20 ft. 6¼ in. These rails are bolted to transverse steel girder sleepers placed 5 ft. apart. Between the sleepers the rails rest on hard bricks, and sleepers and bricks are all embedded in concrete. The total weight of the engine is about 140 tons, including racks, rails and lagging.

The cast iron engine beds are mounted on this carriage with two layers of timber between. The interposition of timber reduces tremor, and one of the two layers is removable to make room for a larger cylinder or cylinders if and when necessary.

Mention was made of the worm spaces on the crank shaft. In these places worms are keyed to the shaft. They engage worm wheels mounted on horizontal weigh shafts—one at each end of the drum and running at right angles to direction of crankshaft, passing under the latter and extending from front to back of engine. At each end of each weigh shaft is fitted a pinion which engages with an inverted rack of which there are four, attached two each to opposite walls of the engine house parallel with the tracks. The effect of this gearing is, when the engine is running, to cause the girder carriage, engine and all, to travel or traverse in a direction parallel to the drum axis and at right angles to the axial lines of engine cylinders.

The gearing is so chosen that during a complete wind of 1,000 yards the engine moves sideways through 16 ft. This will allow of the use of a round wire rope of 2 in. diameter.

The distance between the centres of ropes in the shaft is 4 ft. 6 in. As the rope of descending cage pays out from and uncovers the drum, the incoming rope of the ascending cage follows up the outgoing rope, and covers a portion of the drum which the outgoing rope has just laid bare.

ADVANTAGES.

The advantages claimed for this type of winder for deep shafts are:—

1. Reduction of first cost.
2. Economy of steam or fuel consumption.
3. Ease in handling and safety in winding.
4. Adaptability as a sinker or permanent winder.
5. Avoidance of side friction and troubles due to obliquity of rope direction.

TO AVOID OVER-WINDING.

To prevent over-winding the following means have been adopted:—A steam brake is arranged to be actuated automatically should the engine ever traverse too far consequent upon over-winding. In such a case the steam brake valve is opened by coming into contact with fixed stops, one of which is situate at each side of the engine-house. The application of this powerful brake pulls the engine up dead, and is a valuable precaution over and above that afforded by the safety hooks, which might be applied to the ropes.

The present cylinders are 24 in. in diameter, with a stroke of 5 ft. The steam pressure is 120 lb. gauge at the boilers.

Since the engine started in July, 1901, the shaft has been sunk from a depth of 738 ft. to the present depth of just on 1,500 ft. (January, 1903). A locked coil-rope of 1 in. diameter has been used. It is of course coiled on the drum, with a space of 1 in. between each coil. A kibble of large capacity has served to raise the rock broken, and besides this work all bricks, mortar and concrete required for lining the shaft have been lowered by the engine. Very little water has been met with during sinking.

ELECTRIC DRIVING.

The system lends itself very well to the use of electric motors for driving. One or two motors may be mounted on the travelling bed to drive the drum by means of gearing, with a consequent simplification of construction over that required for a steam engine. For the latter walking steam pipes are necessary, but current may be very simply supplied to moving motors by means of loose leads. Another advantage possessed by motor driving is that the engine could be perfectly balanced, as all the moving parts would be revolving. To balance completely the reciprocating and revolving masses of a 2-cylinder engine is not possible. A partial balance may be effected, however, and the remaining unbalanced forces are not likely in any case to cause trouble in a traversing engine through a tendency to oscillate around a vertical axis. Since the question of excessive piston speed would not arise when driving electrically, the drum could be run at a greater number of revolutions per minute than when driven by a steam engine, and hence the diameter of the electrically driven traversing engine drum might be even smaller than that of the steam-driven traversing engine drum.

THE ROPE COILS.

It is generally held that winding ropes for great depths should be tapered. If such a rope were used in connection with a traversing engine it would be necessary to set the speed of traverse to suit the largest diameter of the rope. The coils of rope on the drum would lie with a constant distance between centres of consecutive coils, but whereas the coils at the thick end would nearly touch one another, those at the thin end would have an increased interval between them.

In order to be able to use a balance rope with a tapered winding rope the drum should be slightly conical, being larger in diameter in the centre than at the sides, to the extent of the difference in diameters of the thick and thin ends of the rope. The effective diameter of each rope coil would then be the same, and a balance rope could be used.

DESIGNING ELECTRIC LIGHT STATIONS.

At a meeting of the Society of Engineers, Mr. J. Patten Barber, President, in the chair, a paper was read on "Electric Light Stations, their Design and Arrangement," illustrated by drawings of the Bridlington Electricity Works, by Mr. Ernest R. Matthews, C.E., F.G.S., Borough Engineer of Bridlington.

GROWTH OF THE INDUSTRY.

The author commenced by observing that during recent years the supply of electricity for lighting purposes had become one of the chief municipal industries in this country. He then sketched its early history, and its development, pointing out that in 1882 the attention of Parliament was drawn to it, that the Board of Trade were then convinced that electricity for lighting purposes had a future before it, the result being that the Electric Lighting Act, 1882, was passed. The result of this was that numerous local authorities and private companies applied to Parliament for Provisional Orders enabling them to proceed with installations. Private companies very soon found out that the conditions of the Act were somewhat unfavourable to them, and so they appealed for an amendment, the outcome being that the Amended Electric Lighting Act was passed. The author then noted the rapid progress that was made under this Amended Act, and stated that during the past three years about three hundred and twenty Provisional Orders had been granted, and that of these upwards of three-fourths were for local authorities or private companies in small towns, namely towns under, say, 25,000 population.

THE ENGINE HOUSE.

The author then gave a detailed description of the various points necessary to be observed in designing an electric light station, illustrating his remarks by drawings of the proposed Bridlingtion Electric Light Station, which he had designed, and which was about to be carried out. He first dealt with the engine house, and pointed out that it was a great mistake to cramp up an engine house, that the floor area should be full and sufficient, and that ample space should be left not only between each engine, but also adjoining each wall of the engine house. He then referred to the necessity of making provision for future extensions by building a temporary end. Plenty of head room was necessary in order that the overhead crane could run to and fro with perfect freedom. The walls, he considered, should be built in cement mortar, and should be calculated to withstand not only the strains due to the overhead crane and the thrust of the roof, but also the vibration set up by the engines. Piers built in cement should support the girders or arches carrying the overhead traveller, and it was a most decided advantage to have the walls of an engine house lined with glazed bricks. He considered that a 10 ton crane, worked by hand from the floor by ropes, was quite sufficient for a small station. Plenty of light was necessary, and he recommended that one-seventh of the roof surface should be skylight, and about one-sixth of the total wall area windows. Ample ventilation should be provided, chiefly by means of hopper ventilators in the windows, and by means of the glazed roof ventilators.

The engine bed would vary from 5 ft. to 20 ft. in thickness, according to the type and weight of the engine. The floor might, with advantage, be paved with red Staffordshire encaustic tiles, laid herring-bone fashion, on 6 in. or 9 in. of concrete, the cover plates of the trenches being filled in to match the floor. A convenient size for the trenches, he thought, was 2 ft. 6 in. wide by 2 ft. deep. The drains should have manholes at intervals; the roof should be supported by light steel roof trusses; brackets should be inserted in the walls to carry pipes, and there should be a pair of broad doors, running on rollers, at the temporary end.

THE BOILER HOUSE.

The floor area of the boiler house would depend on the number, size, and type of boilers; the Bridlington boiler house measured 63 ft. by 33 ft 6 in., and it accommodated two Lancashire boilers, each 7 ft. 6 in. diameter, and 30 ft. in length. In calculating the weight of the boilers for foundation purposes it was necessary to include water and fittings. Concrete 2 ft. in thickness should be sufficient. Provision should be made for future extensions by building one side of the boiler house in a temporary manner. The height might with advantage be from 24 ft. to 30 ft., and the floor should be sunk several feet.

The walls should be built in cement mortar, and plenty of light should be provided by means of a number of large windows placed on the permanent side, and about one-fourth of the roof covered with patent glazing. The ventilation might be by means of hopper ventilators in the windows, and louvre ventilators in the roof. The floor might with advantage be paved with flags on 6 in. or 9 in. of concrete, and the trenches should be covered with wrought-iron checker plates.

The roof should be supported by steel roof trusses, and should be close-boarded. Drainage for the scum and blow-off cocks, water-gauge cocks, etc., should be provided. The coal bunker should be placed as near to the furnaces as possible, and an inclined footway should lead to the boiler house for the purpose of wheeling ashes out. Care should be taken in the arrangement of the doors, and the flues should be lined with 9 in. of fire-brick, radiated bricks only being used.

ACCUMULATOR ROOM, ETC.

The accumulator room should not be cramped for room; it should be light, well ventilated, and might be paved in the same manner as the engine house. It should be not less than 13 ft. or 14 ft. in height. Two store-rooms should be provided, one to contain heavy goods, the other oil, waste, and lighter goods. No works are complete without a meter-room. There should be a workshop sufficiently large to contain lathes, drilling and milling machines, fitters' benches, forge, etc. A convenient size is about 25 ft. by 14 ft. The engineer should have a private office fitted up with desk, drawing table, cupboard, and other suitable fittings. A convenient size for the men's room is 20 ft. by 10 ft. The water-storage tank should be formed of square cast-iron plates, planed to template, and strongly stiffened with brackets, and flanged

CHIMNEY SHAFT.

Referring to the chimney shaft, the author observed that where the buildings were intended to be permanent, a brick shaft should be erected, which might be square, octagonal, or round. The wind pressure on the two latter was stated to be considerably less than on the former, the relative pressures being: Square, 1·0, octagonal, 0·65; round, 0·5. The external width of the shaft at the base should be, if square, one-tenth of its height, if octagonal, one-eleventh, and if circular, one-twelfth.

FOUNDATION AND BRICKWORK.

The author then dealt with the foundation, observing that, given a good clay foundation, a chimney 150 ft. high might stand on a good bed of Portland cement concrete (5 or 6 to 1), 20 ft. or 22 ft. square, by 7 ft. or 8 ft. thick. The concrete should remain three weeks before any brickwork is placed upon it, and all the bricks should be of the same density.

He then dealt with the thickness of the brickwork, also the bond, which should be one course of headers to three or four courses of stretchers. The mortar should be lime mortar and not cement mortar, which was too rigid. The brickwork should proceed slowly, say three or four feet per day. The cap might be of iron, terra-cotta, or stone, and should not project more than the thickness of the brickwork. The shaft should be lined to a height of at least 30 ft. for ordinary heats with a fire-brick lining. The lightning conductor should not be carried around projections, but through them.

It was mentioned that the tender of Messrs. G. Storr and Son, contractors, of Bridlington, for the buildings had been accepted, the contract amount being £5,283. The consulting electrical engineer is Mr. J. H. Medhurst, B.Sc., M.I.E.E., of Westminster, and the total estimated cost of the works is £26,000.

COMING EVENTS.

August.

1st.—North of England Institution of Mining and Mechanical Engineers: Annual Meeting.

13th.—Mining Institution of Scotland: General Meeting at Hamilton.

15th.—Institution of Junior Engineers: Summer Excursion to Sheffield—L'Association Suisse des Electriciens: General Annual Meeting opens at Lausanne.

29th.—Midland Counties Institution of Engineers: Annual Meeting at the Midland Counties Institution, Nottingham.

NEW CATALOGUES & TRADE PUBLICATIONS.

The C. W. Hunt Company, of West New Brighton, New York.—We have received from the above firm a neat portfolio containing a series of pamphlets describing and illustrating (1) their Machinery for the economic handling of coal, with examples, sectional drawings, etc. ; (2) Industrial Railways for shop transportation, giving reproductions from photographs of many installations in all parts of the world ; and (3) the "Stevedore" Manila rope for transmission and hoisting. Pamphlet 0228 illustrates and briefly describes the various Electric Hoists manufactured by this company. Their "Straight Line Hoist" is a standard hoist for general work, with enclosed gearing, friction clutch, band brake, controller and complete electrical equipment. It is made in all sizes from five to one hundred h.p., and can be "safely used in situations where flying sand and grit would rapidly destroy exposed gearings." Other specialities mentioned are :—"The Cargo Hoist"—which is especially useful for hoisting package and bag freight from vessels, and is advantageous when economy in floor space is important. "The Special Hoist," for heavy and large drums required in mining work. "The Double Drum Mining Hoist," for mines, inclines, and tail rope haulage. The "Special Double Drum Hoist," for coal hoisting. An Electric Winch, for use on board ships, docks, in warehouses and unloading lighters, etc. Direct or alternating motors can be used in connection with these hoists, and every part is made on the interchangeable system.

Harry Puplett, of 47, Victoria Street, Westminster, as London representative of Messrs. Henry Balfour and Co., engineers and ironfounders, of Leven, Fifeshire, has issued an excellent little illustrated pamphlet of eighteen pages, describing the various machines and works that have been constructed by his principals. The most important specialities mentioned are structural work in steel and cast iron, for electric light and power generating stations, gas and engineering works, stores, etc , comprising roofs, girders, columns, staunchions, chequered floor plates, tanks, etc. ; gas works plant, including retort house fittings, mouth-pieces, self-sealing lids, ascension pipes, hydraulic mains, condensers, tar extractors, "annular" brush washer-scrubbers, purifiers, hydraulic lifting gear, four-way bye-pass valves, valves, and connections, etc., contractors' and engineers' plant, coal-mining plant, etc., etc.

John H. Widdowson, Britannia Works, Salford, Manchester.—Catalogue of 46 pages and cover, illustrating and describing screwing apparatus, working and machine taps, "Whitworth Screw Thread," engineers' fluted rymers, "Belleville" boiler taps, an improved tube plate tapping apparatus, complete outfits for steamships, etc. etc. A price list of most of the specialities is also given.

The Electrical Mining Company, Ltd., Derby. — An illustrated booklet of 40 pages, printed in two colours, with embossed cover, describing electrical machinery and accessories, specially designed and manufactured for mining work, including double-acting open-type engines, multipolar and multiphase alternating generators and motors, rope and other haulage gearing, electric crabs, electrically driven screening plant—tipplers, creepers and conveyors, pumps, coal-cutting machine and drills, ventilating machinery, etc., etc. Specifications and prices are also given.

Simon Craves, Ltd., Manchester.—A pamphlet of 24 pages and cover, with large insets of line drawings, entitled "Cool Washing and Screening Plants" (Baum's system). We are informed that the three operations of screening, washing and sizing, "have been brought to perfection" by means of this system, and among the advantages claimed by the proprietors are the following : (1) Reduced first cost of the washing plant. Generally only one or two washing machines, or—in exceptional cases—three, are necessary. (2) Saving of about 30 per cent. of ground space. (3) Saving of about 30 per cent. of driving power, required. (4) Saving of about 25 per cent. of labour owing to the smaller quantity of apparatus requiring supervision. (5) Saving of about 50 per cent. in upkeep, due to the diminished quantity of apparatus and motive power, and also to the suppression of pistons and shocks. (6) The coal being classified just before loading into wagons is exactly sized, which is not the case when the washing, etc., is done between the sizing and the loading. (7) Minimum increase in small coal by washing. (8) Complete avoidance of loss of coal as slurry, and that in spite of being able to wash the very fine coal dust. (9) Proper drying of the fine coal, and exact regulation of the percentage of moisture.

J. Pohlig, Ltd., Cologne.—We have received from this firm's London representative (Mr. R. E. Commans, of 6, Queen Street-place, E.C.) a neat little brochure illustrating some six or eight wire rope-way installations, which have been erected by Messrs. Pohlig in various parts of the world. One plate showing a span of 2,620 ft. rope-way stretching across a valley near Friedrichssegen is particularly interesting as showing the almost unlimited capabilities and many possibilities of this method of transport.

Richard Klinger and Co., Fenchurch Street, London.—We have received from this firm some half-dozen pamphlets describing amongst others their specialty, "Klingerit." This is a patent joining material for steam pipes, and exceptional advantages are claimed for it, these being particularly apparent in cases where high steam pressures and super-heated steam are used. From a list of complimentary letters received from users, we gather that the material has given entire satisfaction to customers. Another speciality of this firm is a "Reflex" Water Gauge, which has been adopted by the Admiralty, and is used extensively for both land and marine boilers. Other specialities are multiple side feed and mechanical lubricators, restarting injectors, "Safety" isolating valve, etc.

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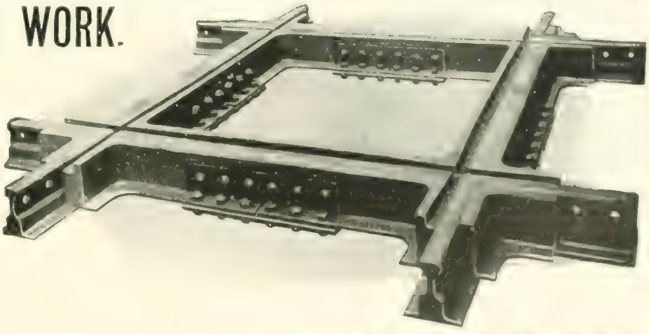

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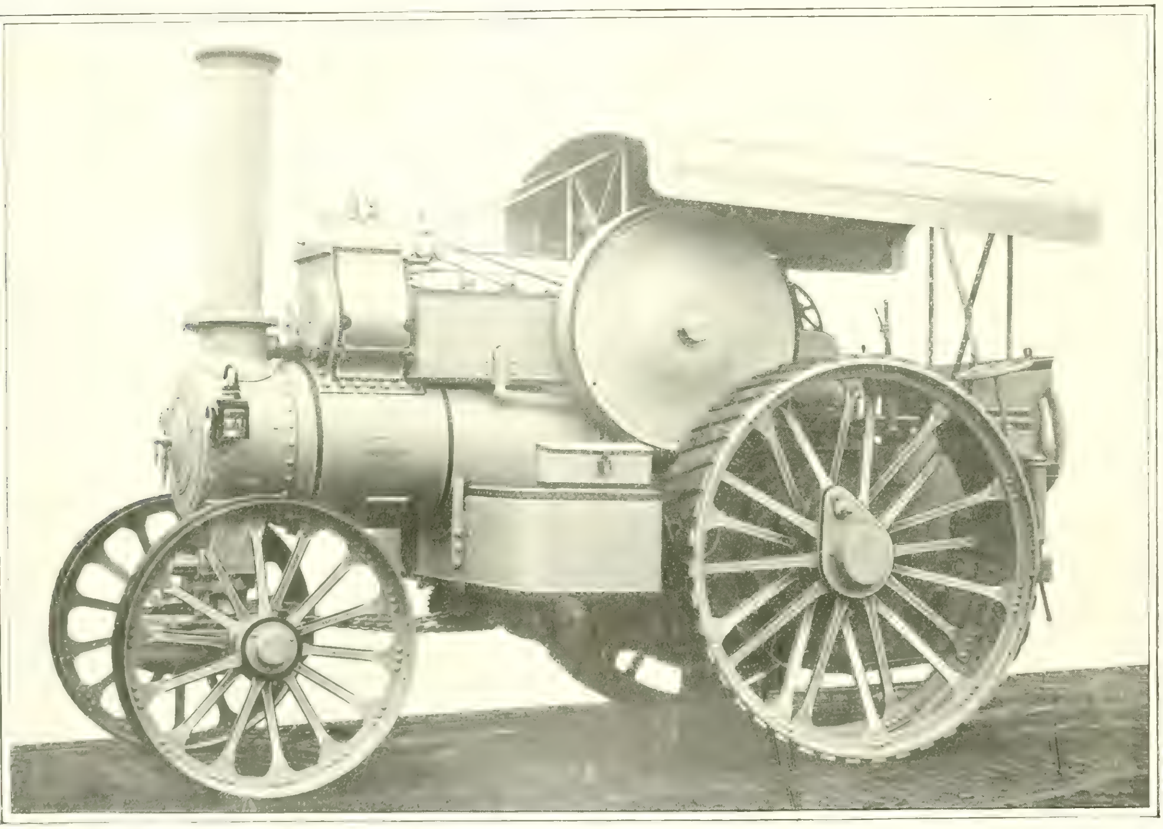

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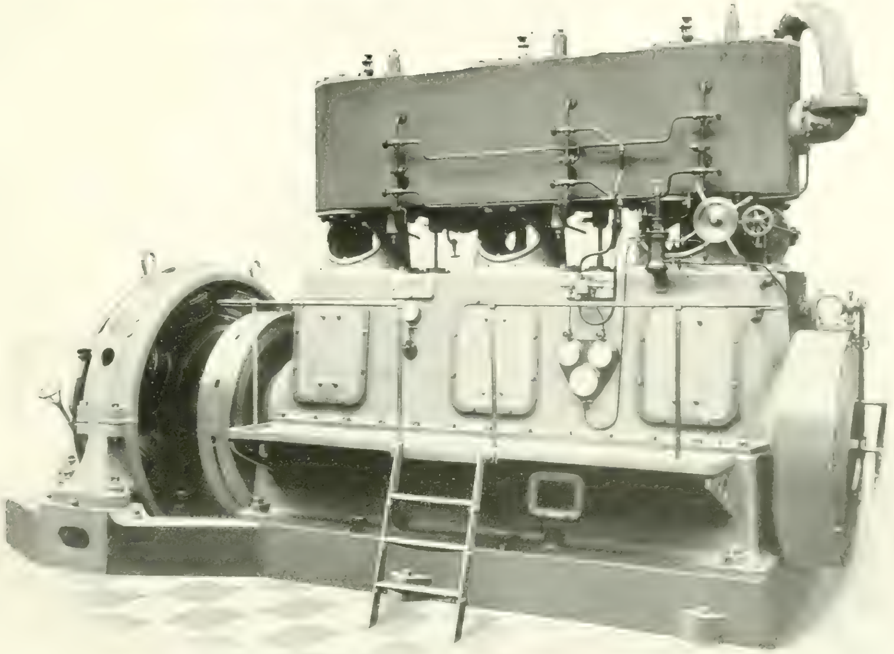

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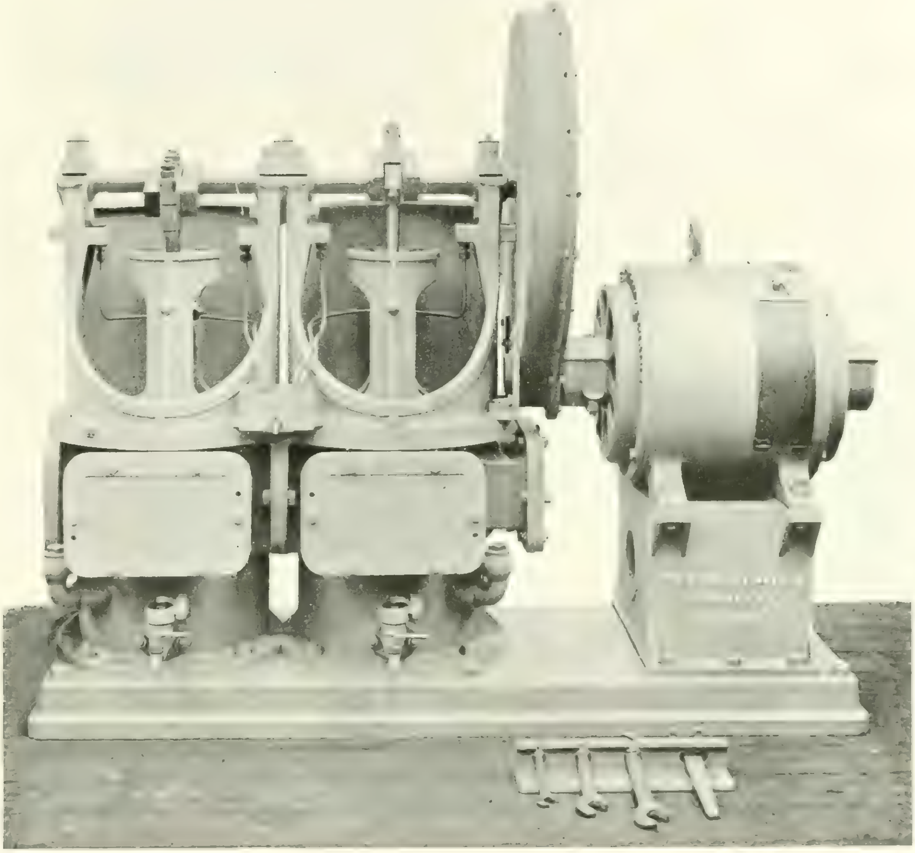

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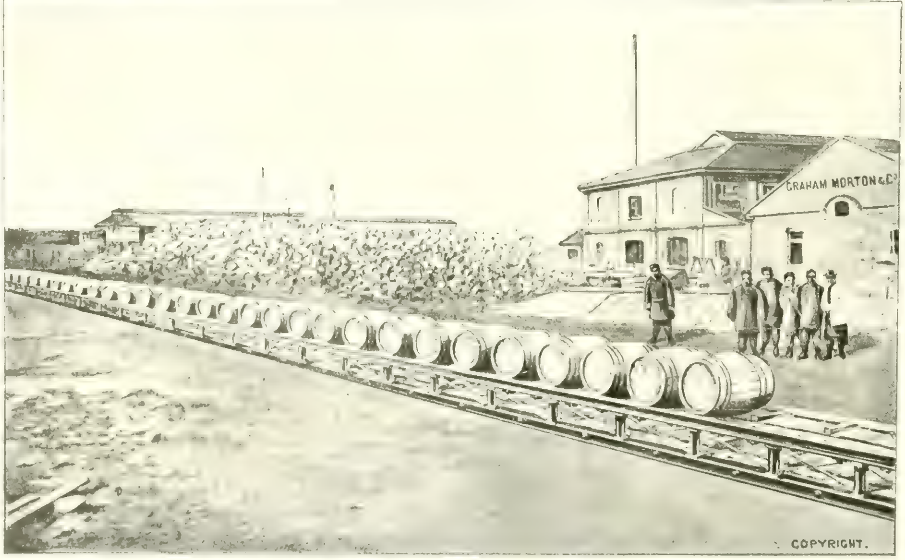

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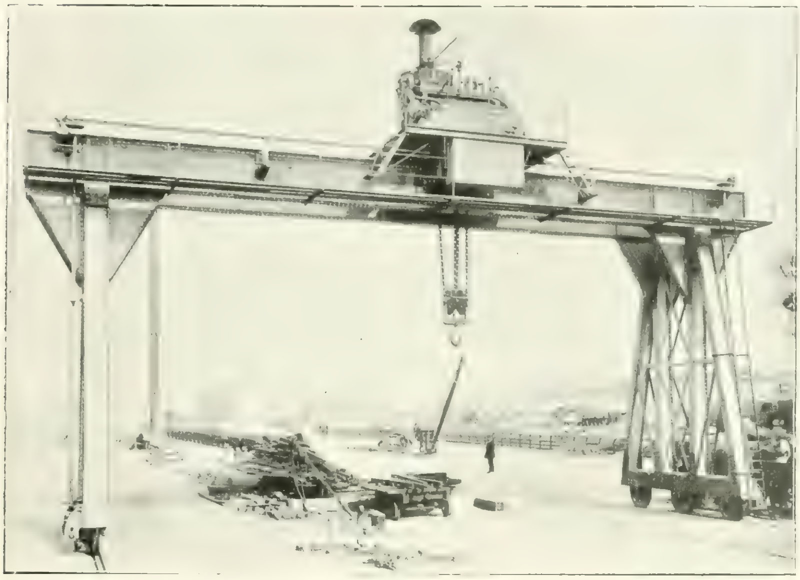

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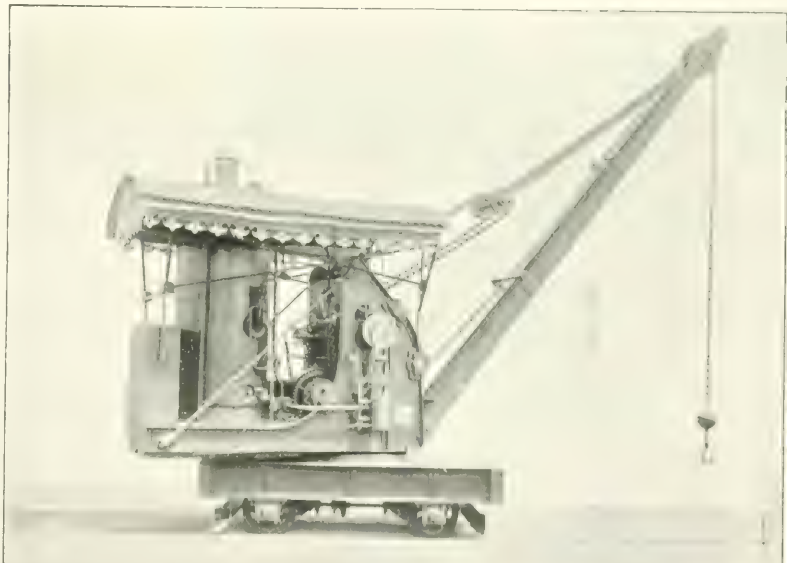

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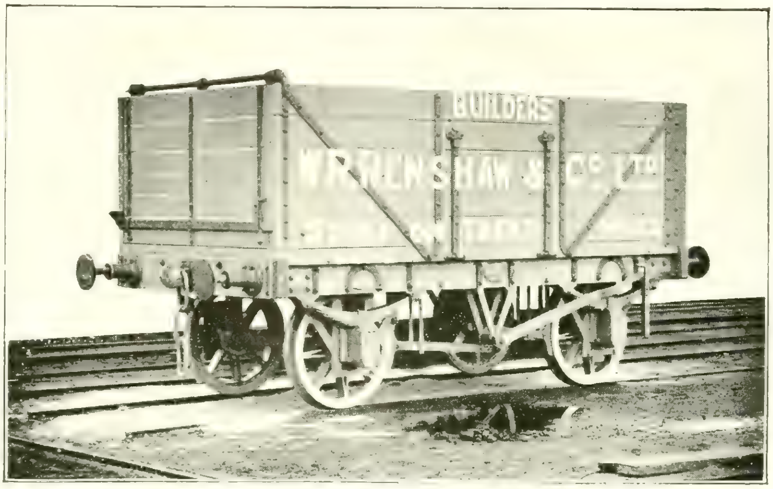

Standard 10-ton Wood Frame Coal Wagon. One end, two side, and two bottom doors.

We have special modern plant for the quick production of . . .

**All-Steel
High
Capacity
Wagons.**

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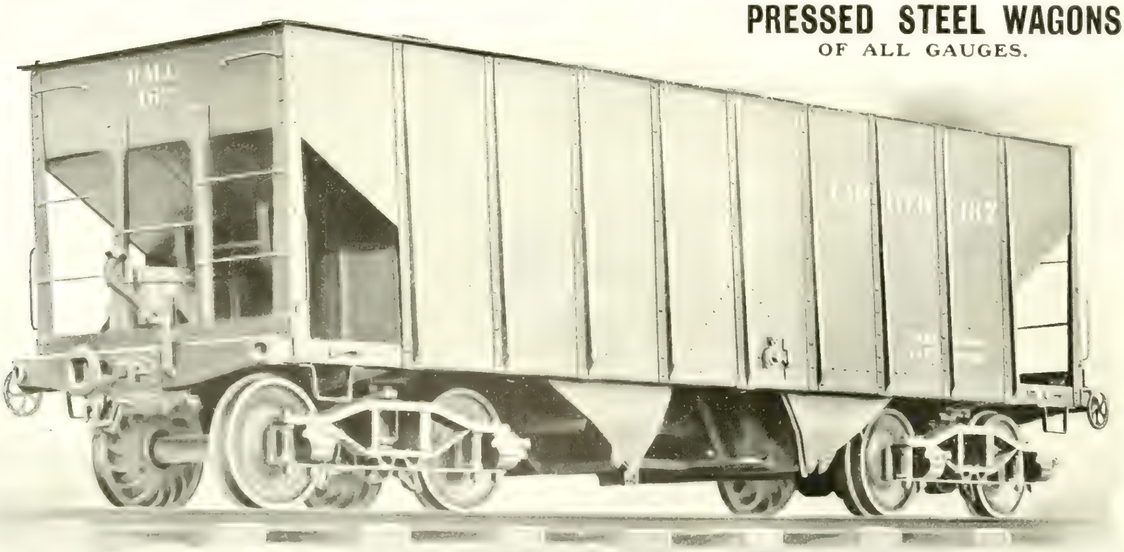
OF ALL GAUGES.



30-Ton Self-Clearing Coal Hopper Wagon, as used in South Africa.

40-ton ALL-STEEL SELF-EMPTYING BOGIE COAL WAGON

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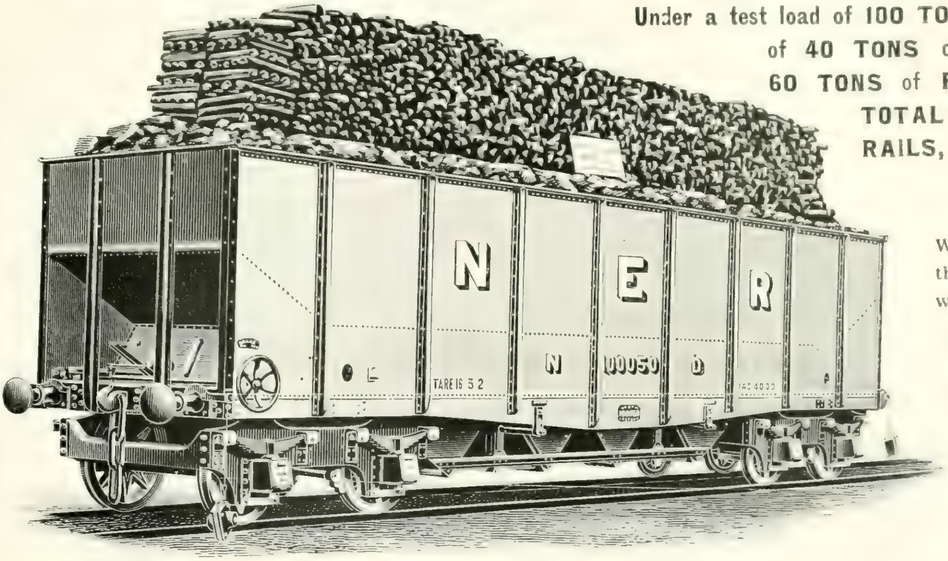

Under a test load of 100 TONS, composed of 40 TONS of COAL and 60 TONS of PIG IRON. TOTAL WEIGHT ON RAILS, 116 TONS 3.

We guarantee this Wagon will discharge 40 TONS in 40 SECONDS.

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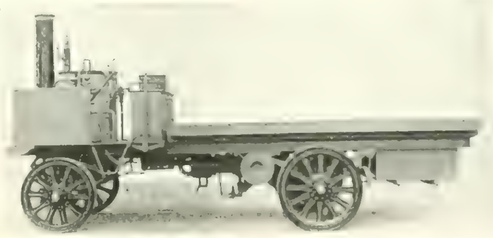

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Send for Revised and Reduced Prices to **TURNER, ATHERTON & CO., Ltd., DENTON, MANCHESTER.**

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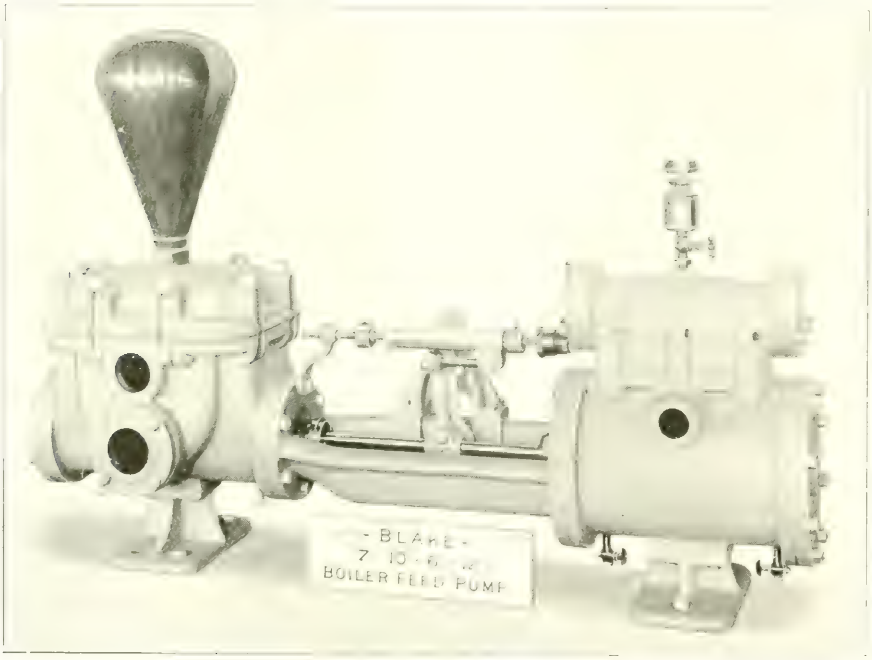

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"SPECIAL" DUPLEX
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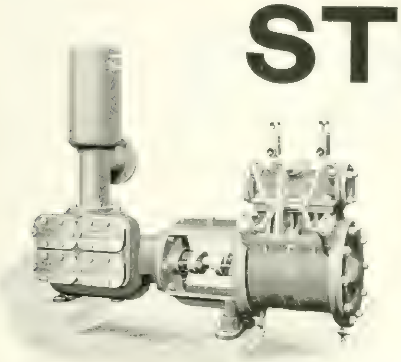

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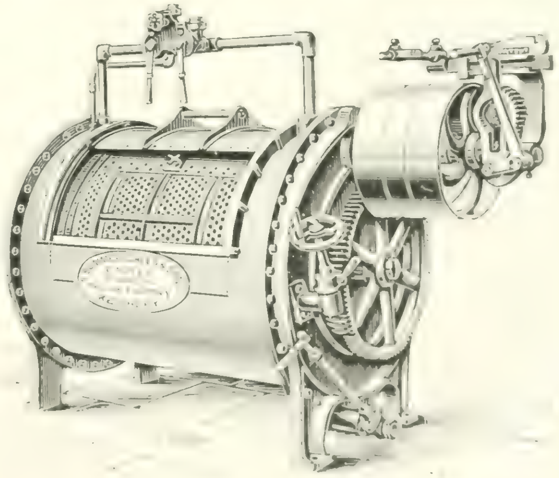

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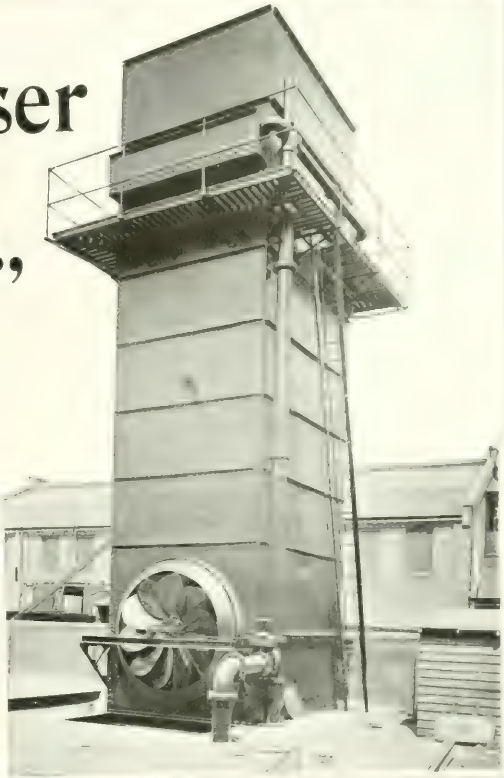

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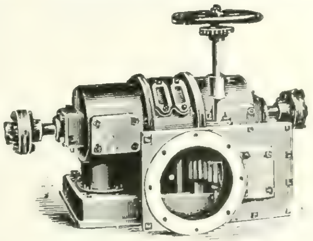

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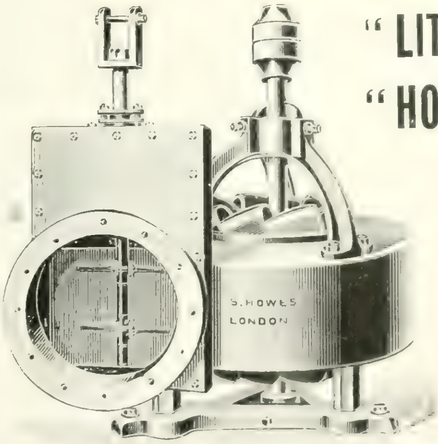

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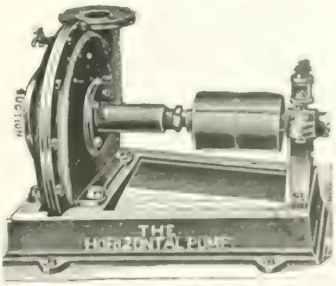

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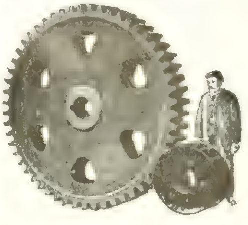

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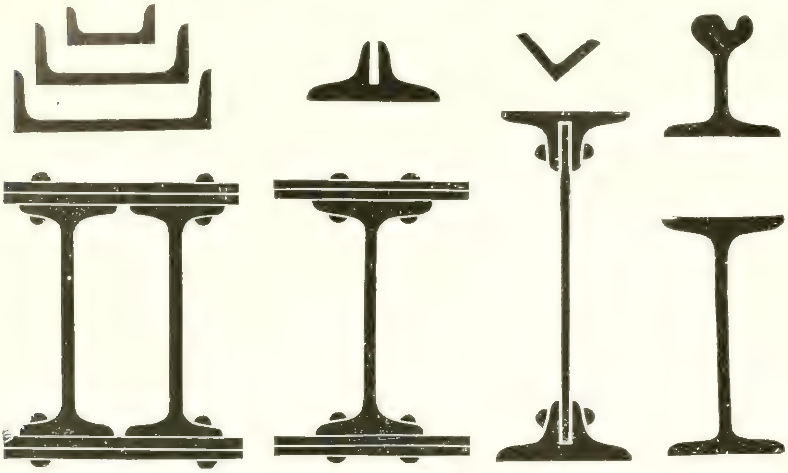

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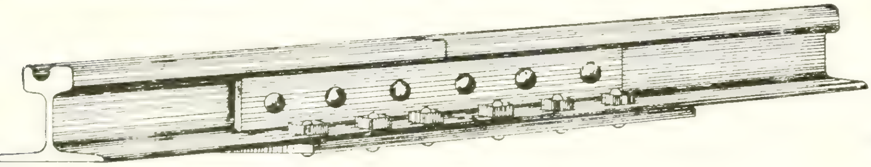

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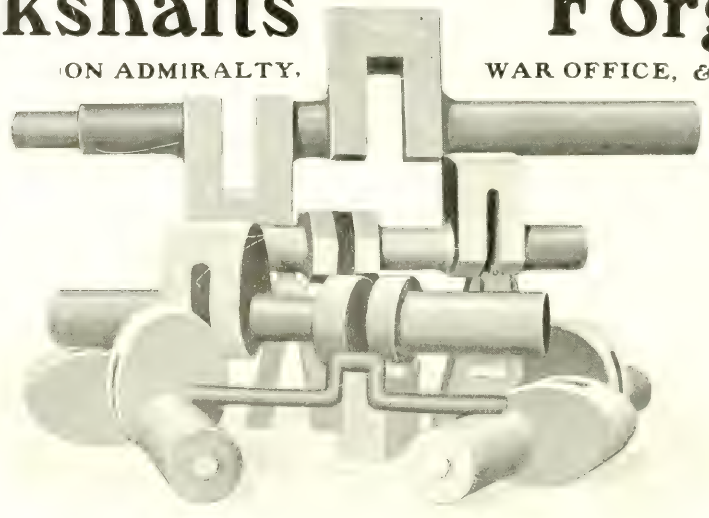

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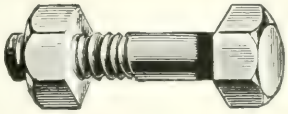

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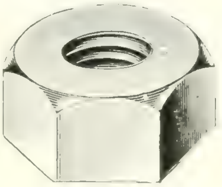

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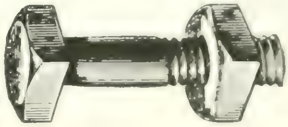

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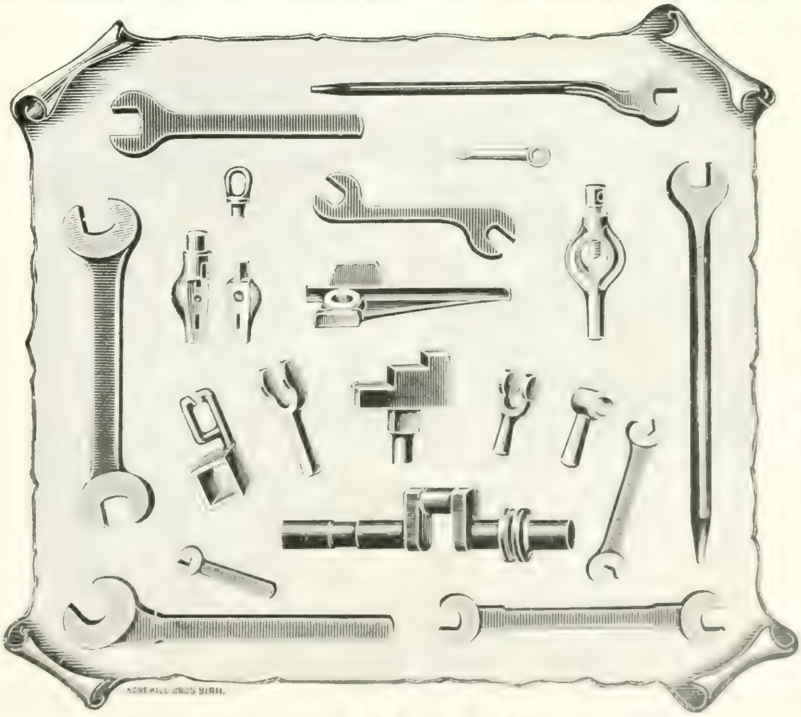

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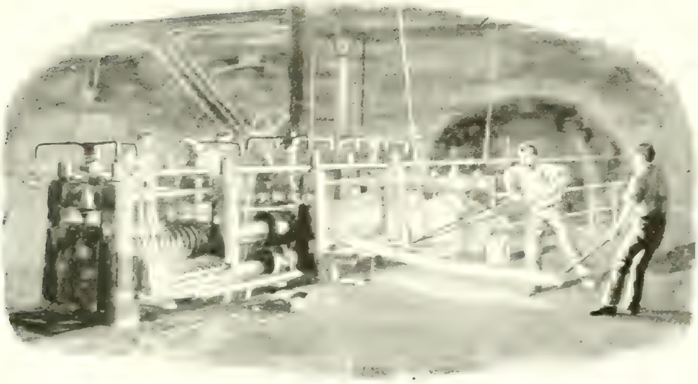

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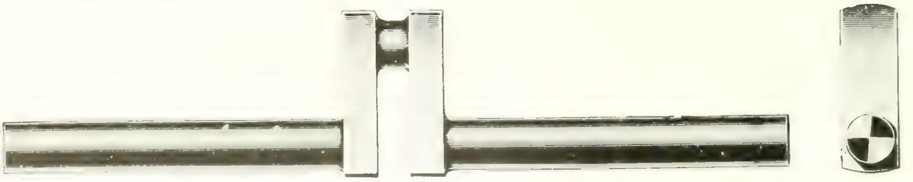

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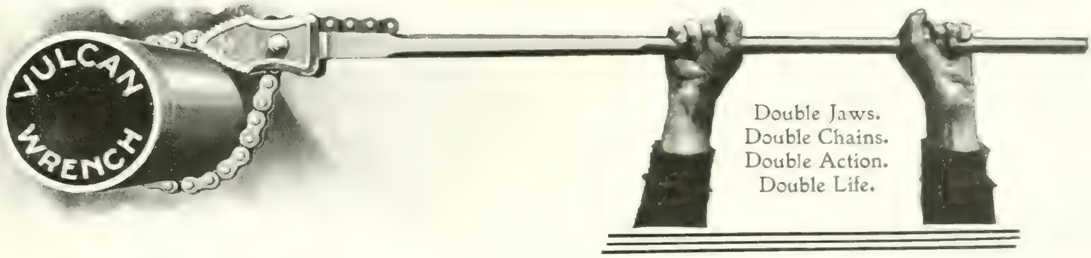

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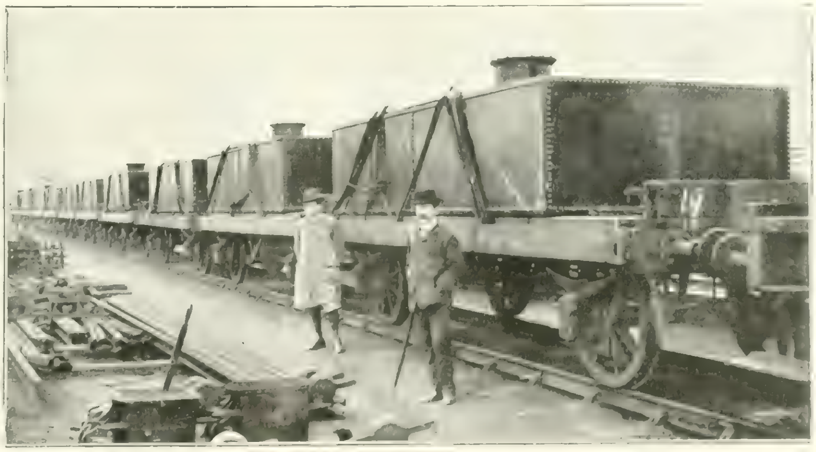

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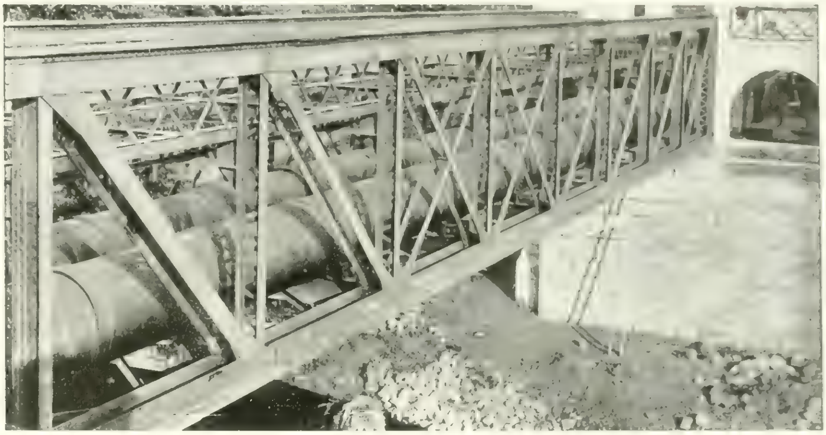

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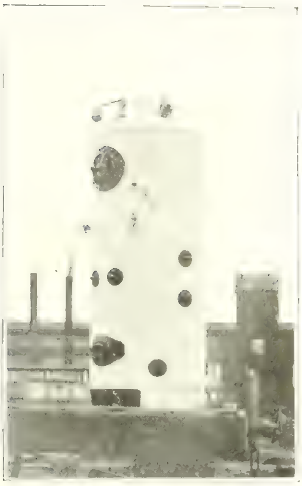

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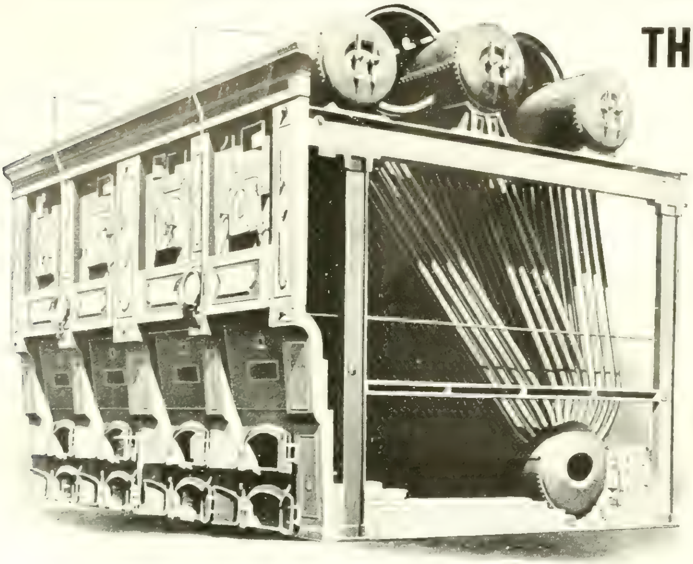

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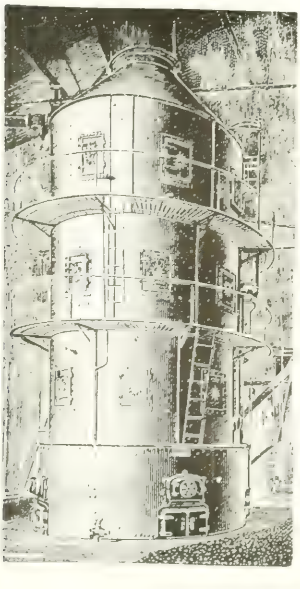

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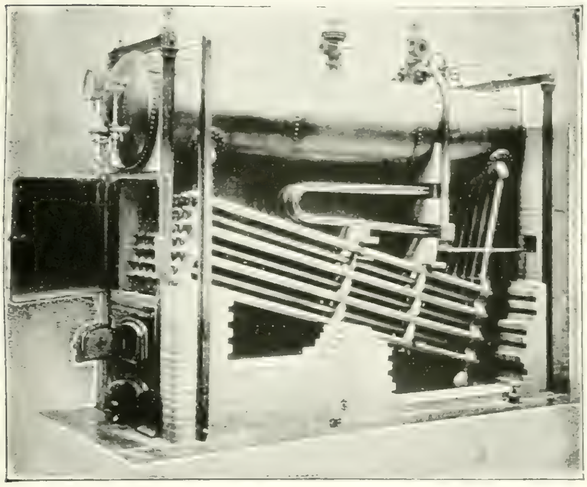

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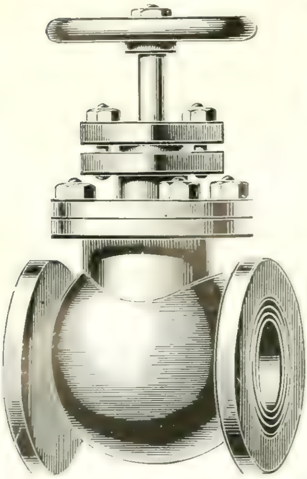

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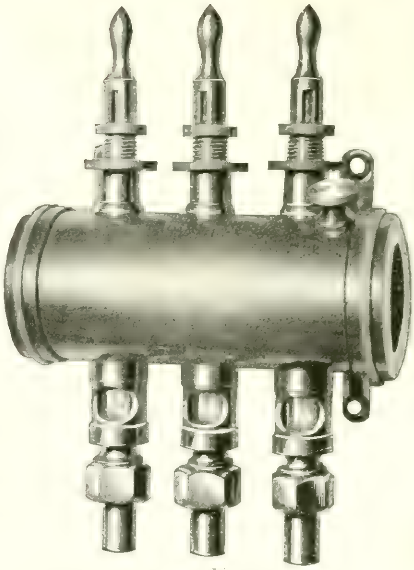

Patent "End Sight" Oil Distributing Box.
No. 881

[illegible]

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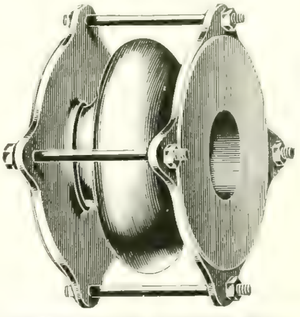
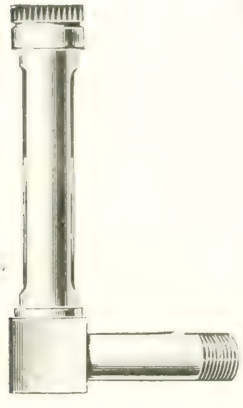
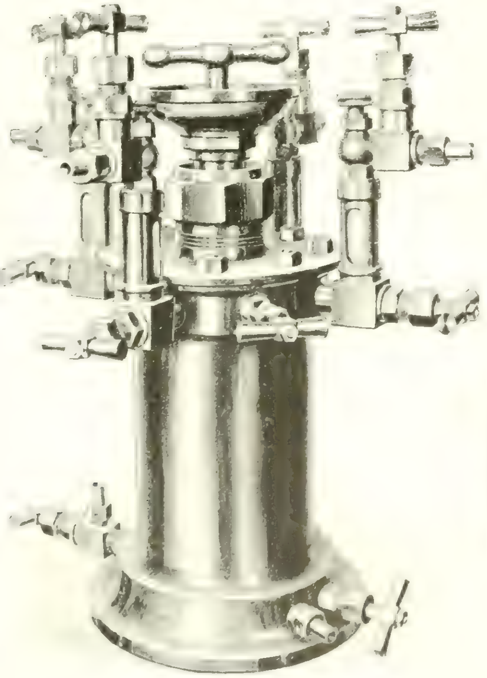


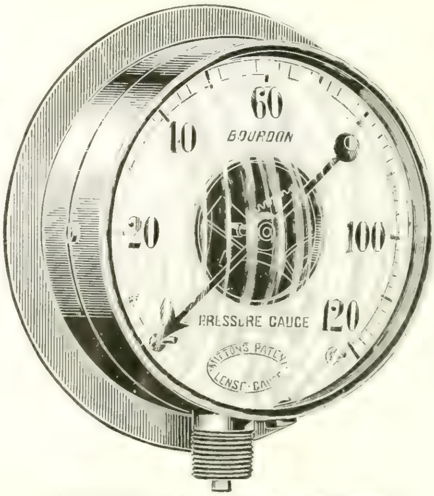
Patent Seamless Copper Expansion Box to take up Expansion of Pipes.



Oil Gauge [illegible]
[illegible]
No. [illegible]



Steam Cylinder Lubricator
No. 863.



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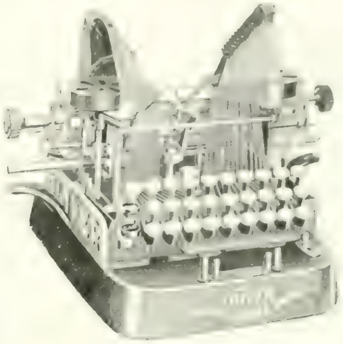

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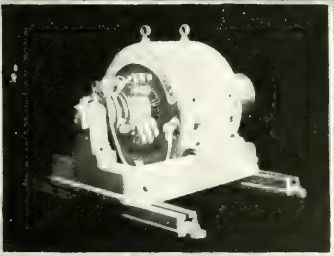

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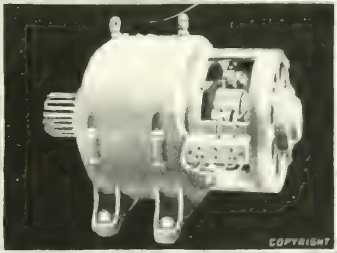

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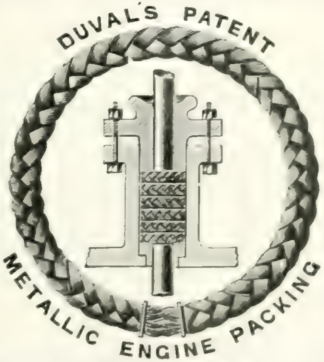

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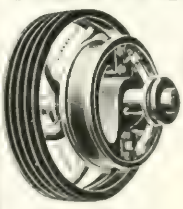

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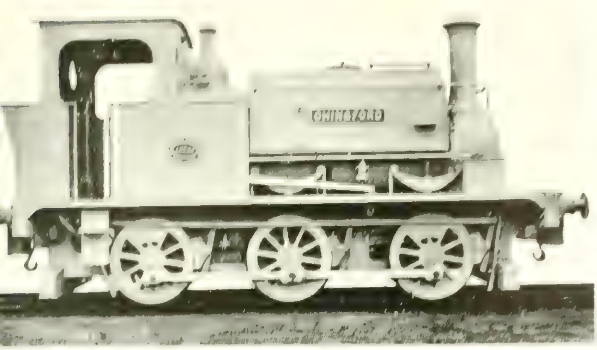

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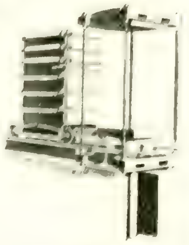

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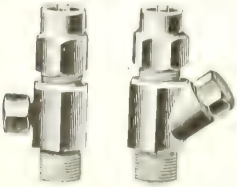

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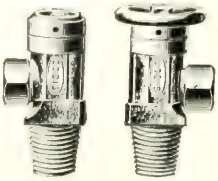

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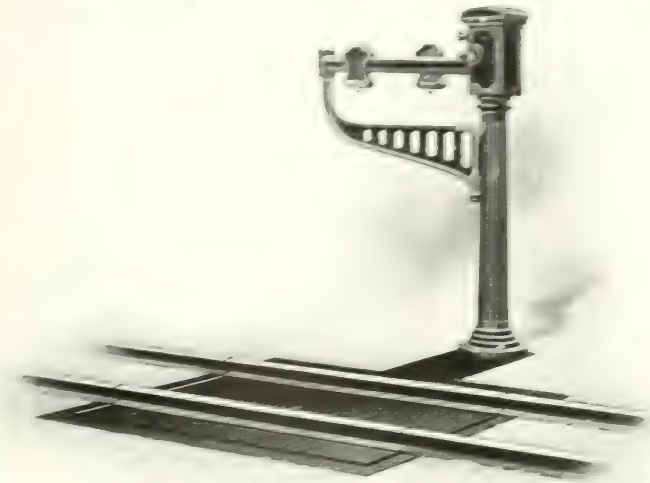

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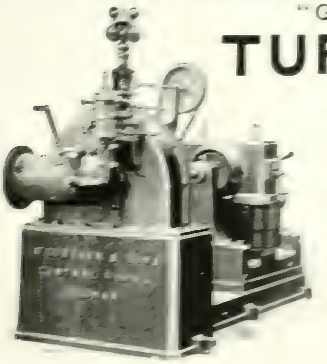

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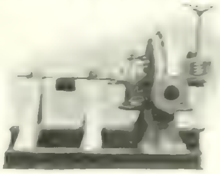

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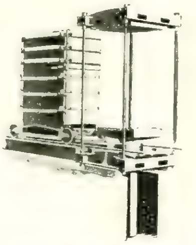
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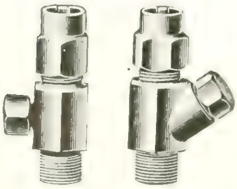

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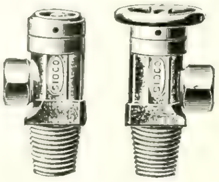

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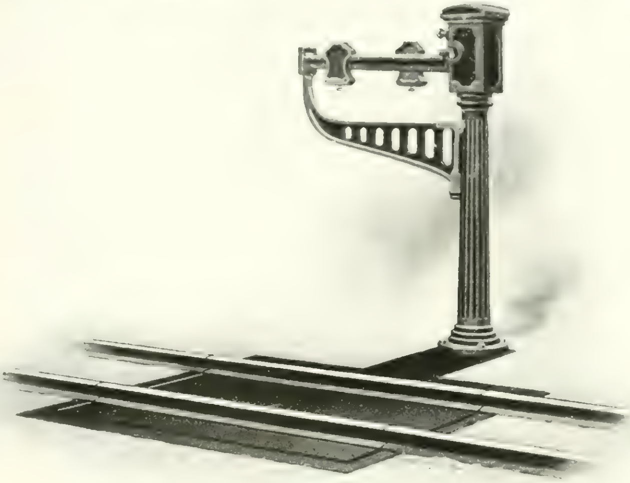

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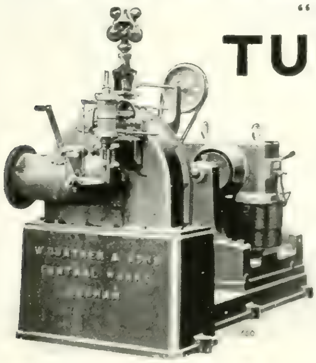

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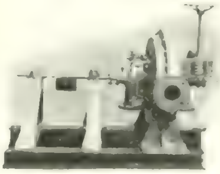

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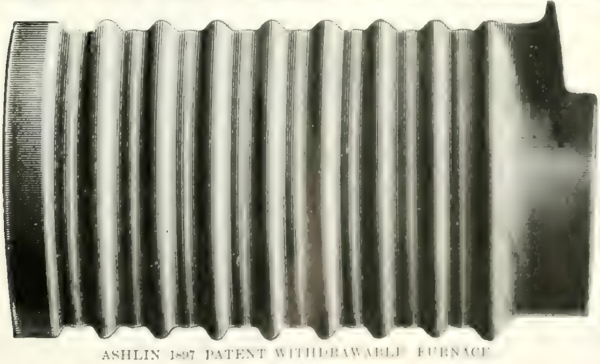

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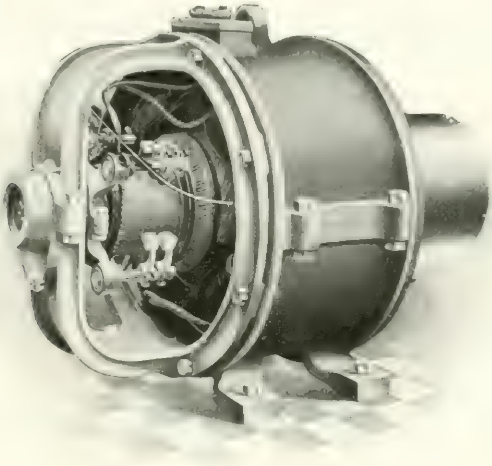

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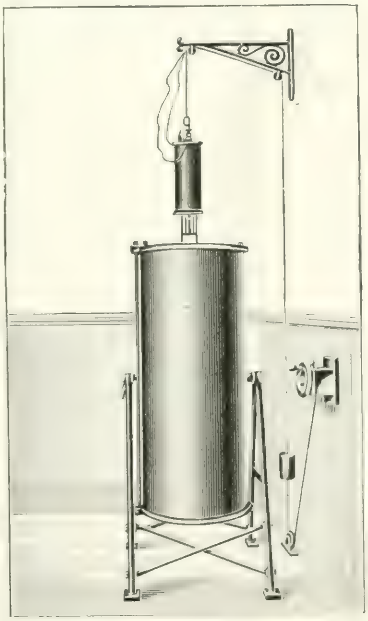

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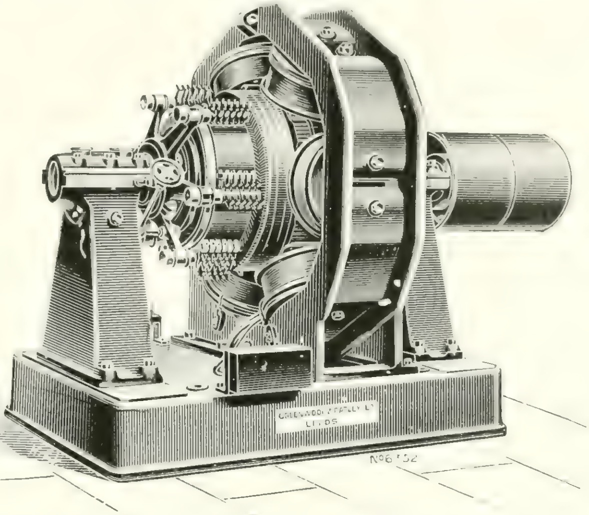

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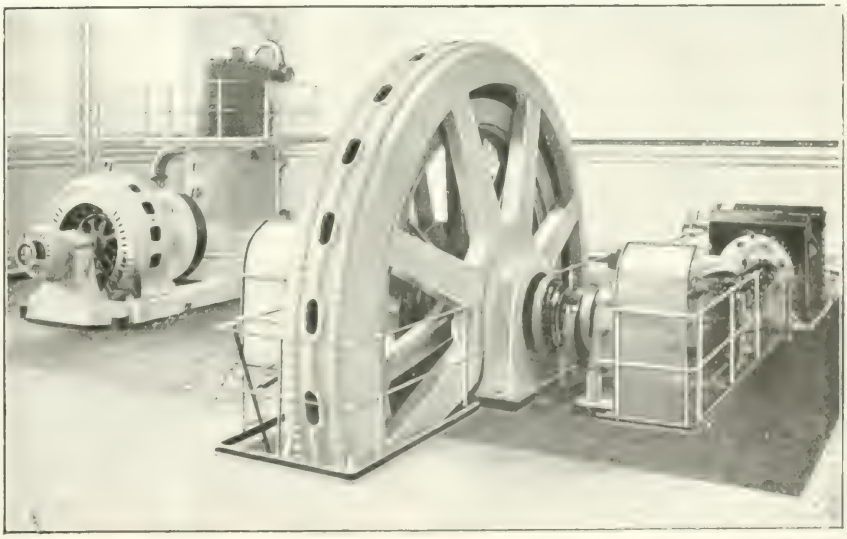

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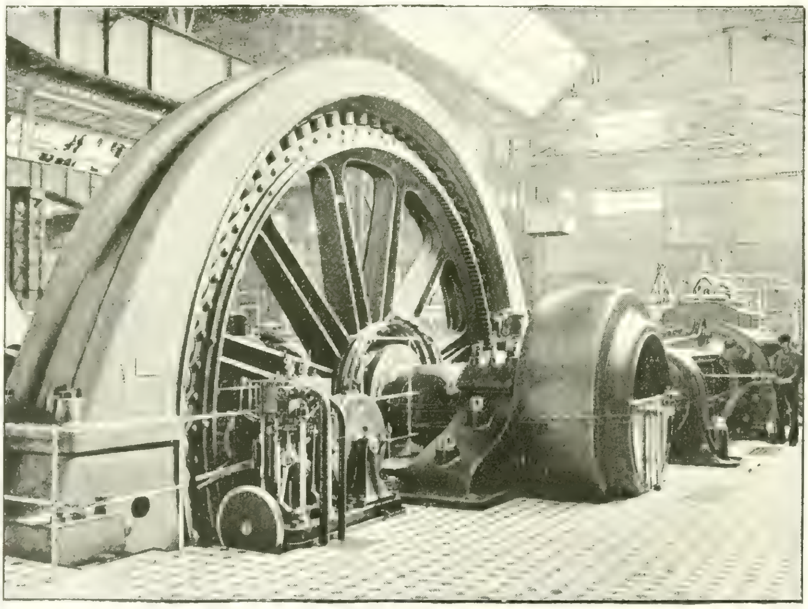

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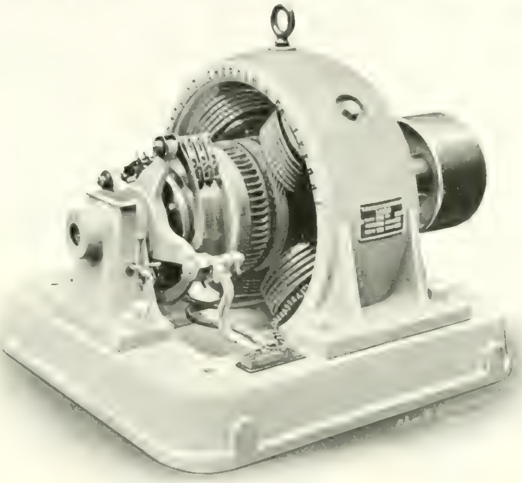

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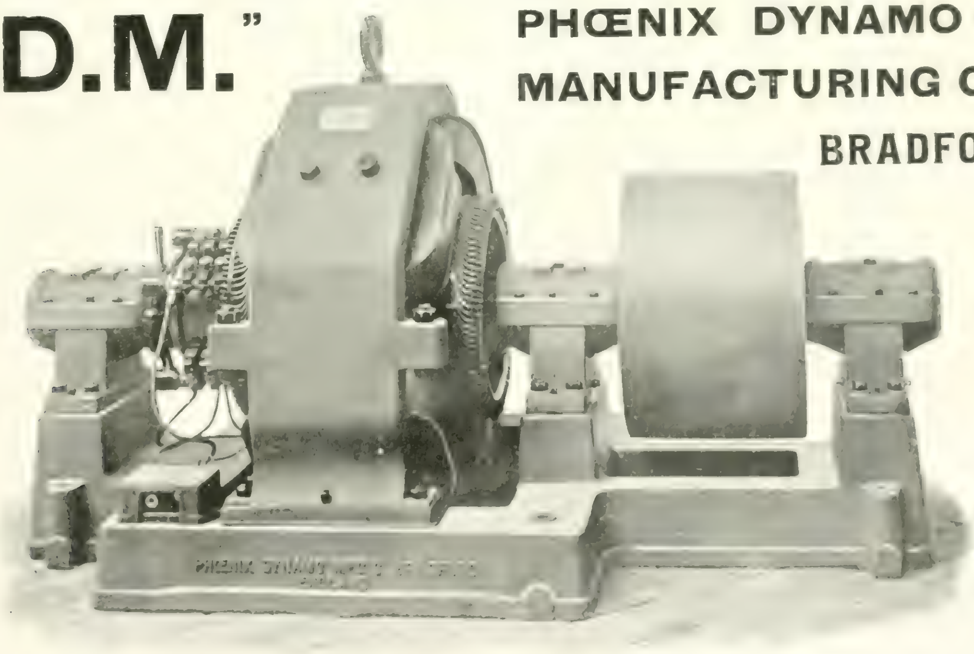

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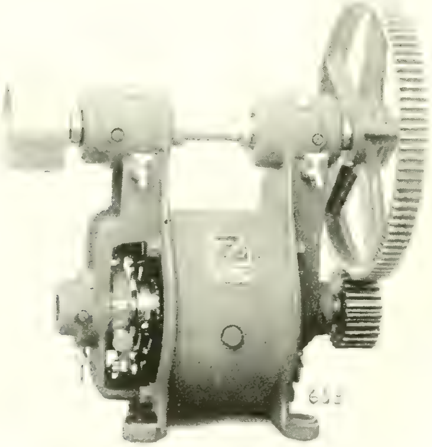

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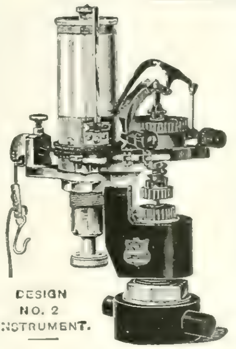

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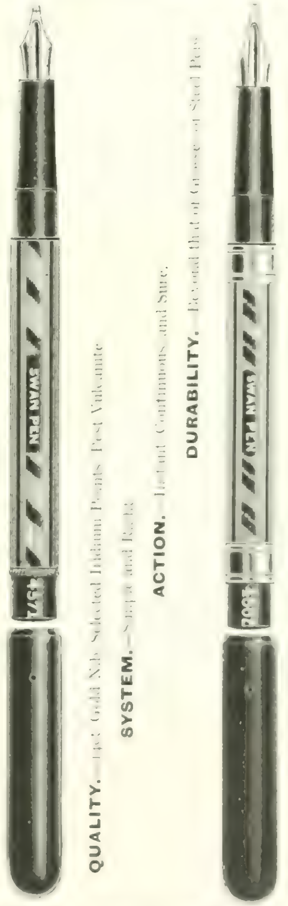

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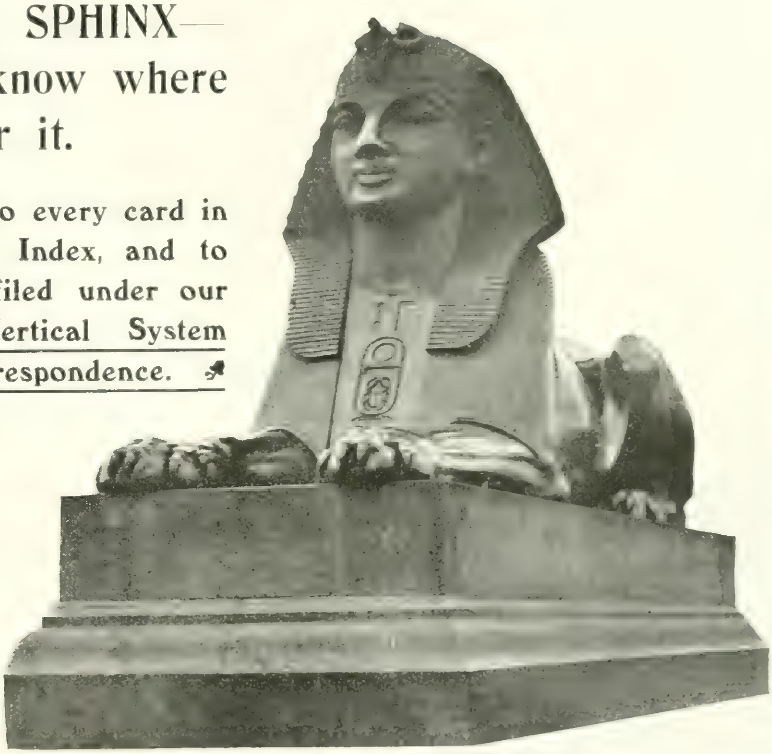

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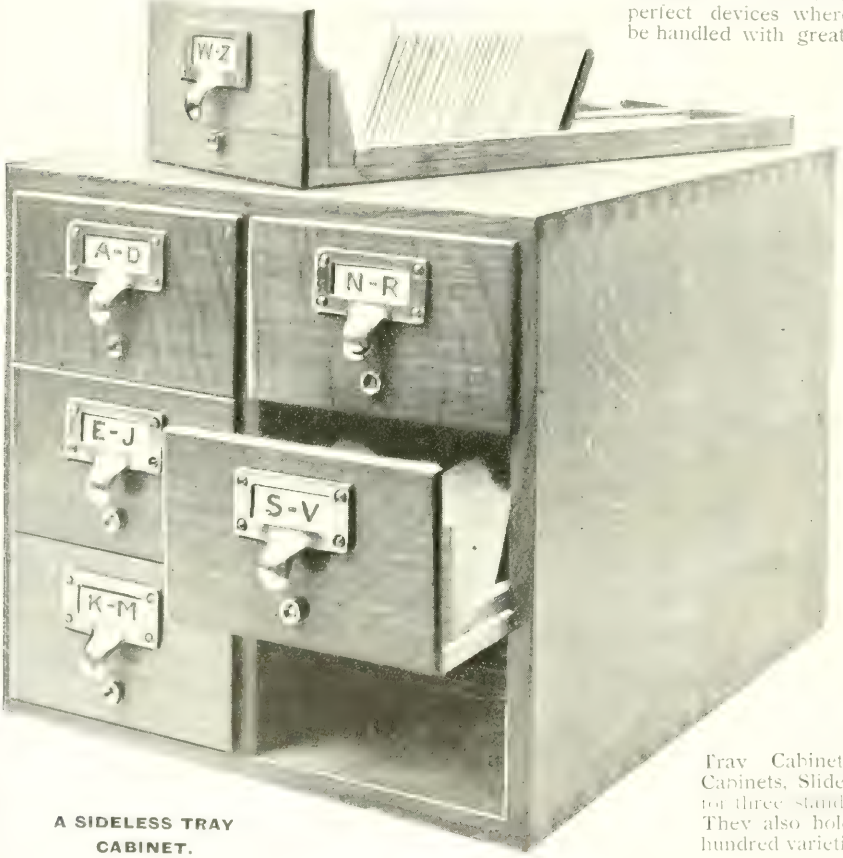

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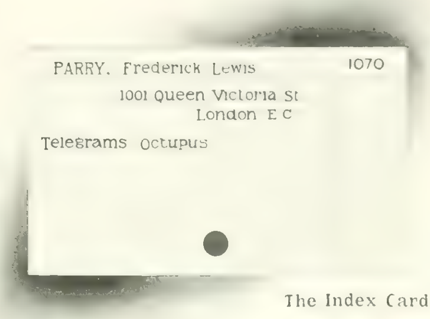
LYLE DOSSIER FILE

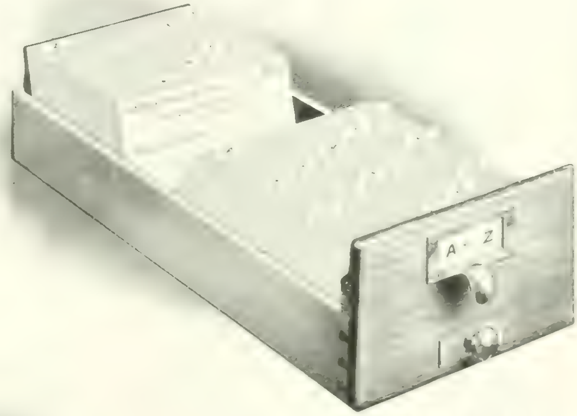
Its History.


PARRY, Frederick Lewis 1070
1001 Queen Victoria St
London E C
Telegrams Octupus

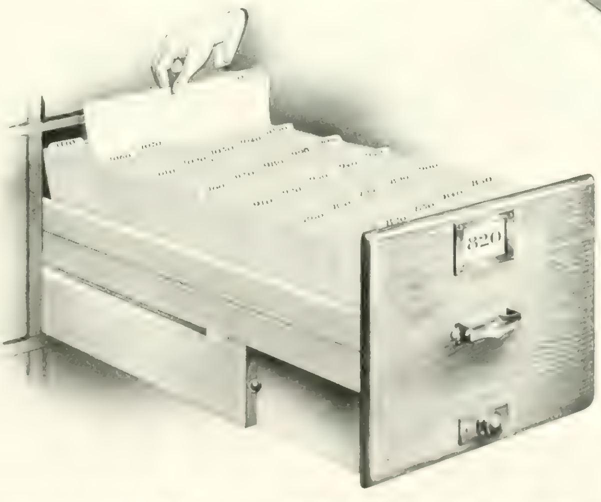
The Index Card.

Catalogue and
full particulars –

THE LYLE Co., Ltd.,
Card Index Experts,
26, Harrison St.,
Gray's Inn Rd.,
LONDON.



The Card filed away in alphabetical order in Card Cabinet, forming index to Dossier.



The Drawer, showing Dossier containing correspondence.

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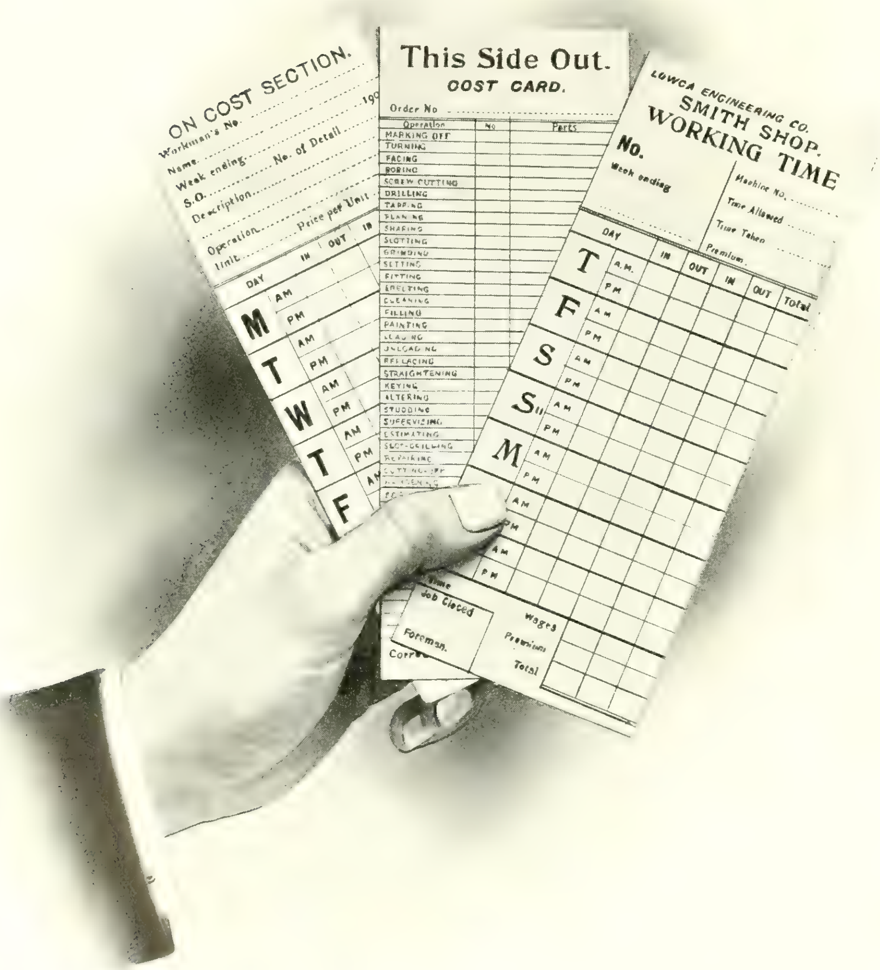
COST-KEEPING.



ON COST SECTION.
Workman's No. ....
Name. 19
Week ending. ....
S.O. .... No. of Detail ....
Description ....
....
Operation .... Price per Unit ....
Unit ....

DAY		IN	OUT	IN
M	AM			
	PM			
T	AM			
	PM			
W	AM			
	PM			
T	AM			
	PM			
F	AM			

This Side Out.
COST CARD.
Order No ....

Operation	No	Parts
MARKING OFF		
TURNING		
FACING		
BORING		
SCREW CUTTING		
DRILLING		
TAPPING		
PLANING		
SHAPING		
SLOTTING		
GRINDING		
SETTING		
FITTING		
ERECTING		
CLEANING		
FILLING		
PAINTING		
LEADING		
UNLOADING		
REPLACING		
STRAIGHTENING		
KEYING		
ALTERING		
STUDDING		
SUPERVISING		
ESTIMATING		
SLOT-DRILLING		
REPAIRING		
CUTTING-OFF		

Time
Job Closed
Foreman.
Corr

LOWCA ENGINEERING CO.
SMITH SHOP.
WORKING TIME
No.
Week ending
Machine No. ....
Time Allowed ....
Time Taken ....
Premium.

DAY		IN	OUT	IN	OUT	Total
T	A.M.					
	PM					
F	AM					
	PM					
S	AM					
	PM					
Su	AM					
	PM					
M	AM					
	PM					
	AM					
	PM					
	AM					
	PM					

Wages
Premium
Total

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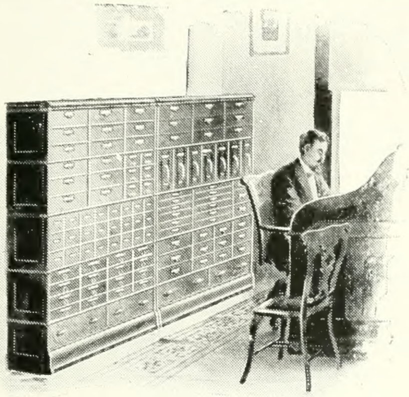

A Handsome Office.

The illustration adjoining shows a corner of an office fitted with Globe-Wernicke Furniture. The two features of the illustration are the application of the Globe-Wernicke Elastic Cabinet System and the handsome Globe-Wernicke Roll Top Desk. These two specialities find a place in most business houses as they represent the highest point reached in the manufacture of convenient and time-saving office furniture. Globe-Wernicke Roll Top Desks are handsome additions to any office. Superbly finished, they hold all the latest improvements, handy, ready drawers, pigeon holes, and other conveniences which add to the busy man's comfort. The roll top locks everything when closed. Made in a variety of seasoned woods, these Desks last a lifetime.

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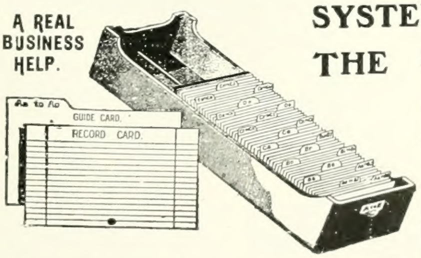

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The Card Index permits of strictly live matter in its contents, and an arrangement of that matter so that, at all times, almost instant reference to any desired name, address, or fact in its make-up can be had. The Card Index also provides for the making of cross references or memoranda in connection with name and address, a thing not possible in the book index.

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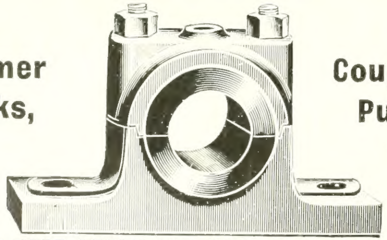

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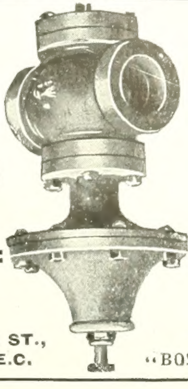

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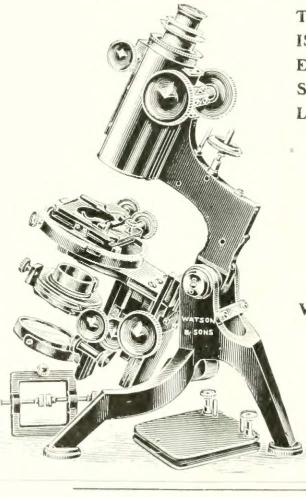

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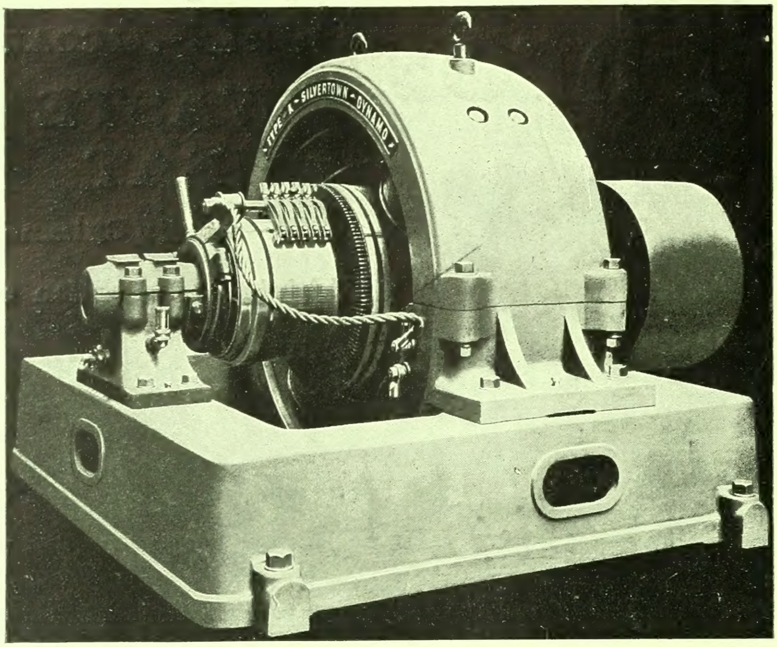

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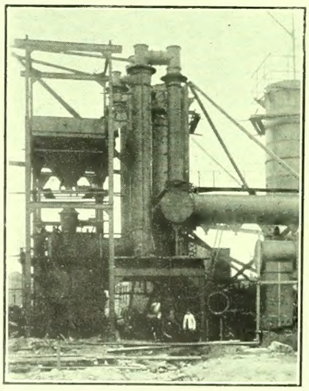

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